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MOCUS - BACKFIRE

User's Manual

by

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User's Manual  
for  
MOCUS-BACKFIRE: A Computer  
Program for Common Cause Failure Analysis

by

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## Abstract

This report is the user's manual for MOCUS-BACFIRE, a computer programme for qualitative common cause analysis. The MOCUS-BACFIRE package code was developed by coupling the MOCUS code and BACFIRE code. The MOCUS code is a computer programme to generate cut sets of a fault tree. BACFIRE is a computer programme to search among the basic events of a minimal cut set for potential common cause failures. Both codes are written in FORTRAN IV for the IBM 360/370 computer series. The input data to MOCUS-BACFIRE are the fault tree and common cause susceptibilities. The input and output of the programme are described in detail in this handbook.

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## I. Introduction

MOCUS-BACFIRE is a computer programme to aid in qualitative common cause failure analysis. Common cause failure analysis is a system reliability technique which attempts to find the single cause or events that can degrade or disable a system by multiple component failures. MOCUS-BACFIRE is a coupled package of the MOCUS and BACFIRE codes [1].

MOCUS [3] is a computer programme that generates cuts sets and path sets from fault trees. It is written in FORTRAN IV for the IBM 360/370 computer series. The algorithm used in MOCUS starts with the top event\* of the fault tree and performs a successive substitution of gate equations, it moves down the tree to basic, independent component failures to resolve the fault tree into cut sets or path sets. MOCUS determines all minimal cut sets and path sets for the top event and all intermediate events upon request. The programme accepts only "AND" and "OR" gates, and all minimal cut sets and path sets of a fault tree are limited to a size of twenty or less.

BACFIRE [4] is a computer programme for common cause failure analysis. The fault tree minimal cut sets are input to the programme. The programme searches through the basic events of a cut set for a potential common cause failure. The potential cause of failure is called a qualitative failure characteristic. A minimal cut set with a common potential cause of failure is called a common cause candidate.

\* A top event is the system failed state described at the top of a fault tree.

BACFIRE is written in FORTRAN IV for the IBM 360/370 computer series. The algorithm searches qualitative failure characteristics of the basic events contained in a minimal cut set to find those characteristics common to all basic events. This search is repeated for all the cut sets. BACFIRE reduces the chance of obtaining erroneous results by input error checking.

Included in this manual are checklists for some generic qualitative failure characteristics. These lists are presented as examples. The analyst can update the lists of generic potential causes of failure as necessary. ( see Table III-1 and Table III-2 )

Section II of this report contains some of the supporting concepts for common cause failure analysis. Section III describes the method for generation of minimal sets and common cause failure analysis which MOCUS-BACFIRE supports. The input to MOCUS-BACFIRE is described in Section IV. The output from MOCUS-BACFIRE is described in Section V.

## II. Definitions and Concepts

### 1) Fault Trees

A fault tree is a graphical representation of the Boolean failure logic associated with the development of a particular top event for a particular system. The fault tree is a model that bridges the gap between the real world and the mathematical model. Construction of fault tree is discussed in details in Reference [5].

The top event of a fault tree occurs when the system passes from the unfailed to failed state. Fault trees represent monotonic structures in the respect that the occurrence of any basic event never decreases the probability of the top event. A given basic event can appear in many places in a fault tree; however, all basic events must represent component failures that are independent from all other basic events.

### 2) Cut Sets

Cut sets are collections of basic events, and if all these basic events occur the system failure is guaranteed to occur. Minimal cut sets are cut sets such that if any basic event is removed from the set, the remaining events collectively are no longer a cut set. A minimal cut set indicates failure; that is, it represents a failed state, when all the basic events in that minimal cut set are simultaneously in the failed state. Therefore, as a minimal cut set indicates failure, the top event occurs. Minimal cut sets are the modes of system failure and are the sets of components that are critical with regard in system failure.

### 3) Path Sets

Path sets are collections of basic events such that if none of the basic events occur, the system failure is guaranteed not to occur. Minimal path sets are path sets such that if any basic event is removed from the set, the remaining events collectively are no longer a path set. For the top event to occur, at least one event in every path set must occur. A path set is failed if one event in the path set is failed.

The minimal path sets can be determined directly from the minimal cut sets and vice versa and are in this respect equivalent sources of information.

### 4) House Events

A house event is an event with a probability of zero or unity of occurrence. House events are useful to a particular analysis to "turn on" or, equivalently, to "mask out" a portion of a fault tree. Also, house events can be used to study the effect of a particular basic event being failed. Many dynamic systems can be analyzed with one fault tree containing house events. Without house events, dynamic systems often require a fault tree for each phase of operation. Skillful use of house events allows much additional information to be extracted from a fault tree that would not be possible otherwise.

## 5) Primary and Secondary Failures

Component malfunctions can be classified into two types:

- i. Primary Failure
- ii. Secondary Failure

A primary failure is a component malfunction for which the component itself is held responsible. A secondary failure is a component malfunction for which the component itself is not held responsible. Responsibility suggests a sphere of the expected environmental and functional inputs in which a component is expected to function properly. A cause of component malfunction which breaches this sphere is a cause of secondary failure.

The component which experienced the secondary failure in response to the occurrence of the cause of a secondary failure is said to be susceptible to that cause of secondary failure. A component may have many different susceptibilities which may give rise to its malfunction. The susceptibilities to the various cause of secondary failure are qualitative failure characteristics of a component malfunction.

## 6) Domain

Some causes of secondary failure are confined by barriers. The volume defined by the barriers to be the cause of secondary failure is called a domain of the cause of secondary failure. Rooms are common domain for many causes of secondary failure, such as moisture and temperature. A diagram of all pertinent domains of secondary failure failures is called a map of causes of secondary failures.

## 7) Sensitivity Ranking

Components vary in their response to a potential cause of secondary failure. The rank of a basic event with respect to a specific generic failure cause is expressed linearly as an integer from zero to nine, which reflects the component's tendency to fail from that cause. Zero is the low end of the scale meaning a low tendency to fail, and nine is the high end of the scale reflecting a high degree of susceptibility to the cause of secondary failure.

### III. Programme Algorithm

The algorithm of MOCUS-BACFIRE consists of two parts:

- i. Generate cut sets from the fault tree, and.
- ii. perform a common cause failure analysis.

To generate cut sets from the input fault tree, the MOCUS code starts with the top event and resolves the fault tree to obtain the minimal cut sets. Boolean algebra is used to resolve the top event in terms of all the basic events. Then the cut sets are simplified to obtain the minimal cut sets. The MOCUS algorithm is shown in Figure III-1.

The objective of common cause analysis is to identify common cause candidates and the qualitative failure characteristics which cause the minimal cut set to be identified as a common cause candidate. In the common cause failure analysis, a minimal cut set is identified as a common cause candidate by either of two criteria.

The first criterion can be met if all the basic events in a minimal cut set are associated by a condition which alone may increase the probability of multiple component malfunction. The second criterion is met if all the basic events in a minimal cut set are susceptible to the same secondary failure cause and are located in the same domain for the cause of secondary failure. A susceptibility common to all basic events in a minimal cut set is not alone sufficient to designate the minimal cut set as a common cause candidate. To meet the requirement of the second criterion, all the components implied by the basic events in the minimal cut set must be located in the same domain for the common cause of secondary failure.

A potential difficulty of common cause failure analysis is the enormous number of secondary failure causes and special conditions. A list of failure characteristics is necessary for the BACFIRE approach in order to maintain continuity throughout the analysis. The list should be of generic causes such that each entry represents a class of secondary failure causes and special conditions. The resolution of these classes should be detailed enough to avoid redundancy and broad enough to maintain physical significance. This list can be organized into categories. One scheme for dividing the list is by the nature of the generic causes, such as chemical or mechanical.

To aid in input preparation to BACFIRE, three categories are utilized for the second criterion. Searching for commonalities by BACFIRE is carried out within a category, but not among categories. The qualitative failure characteristics which are checked by the first criterion must be separated from those checked by the second criterion for BACFIRE analysis. These lists ( Table III-1 and Table III-2 ) can be updated to reflect the important susceptibilities and special conditions of the system being analyzed.

BACFIRE searches the qualitative failure characteristics of the basic events contained in the minimal cut set to find those characteristics common to all basic events by either of the two criteria. The minimal cut set that is identified as a common cause candidate is then listed. The common failure characteristic is also listed with the common cause candidate.

BACFIRE contains the option of determining only those common cause candidates for which the secondary failure susceptibility exceeds some minimum sensitivity ranking for each event. The algorithm of BACFIRE is shown in Figure II-3.

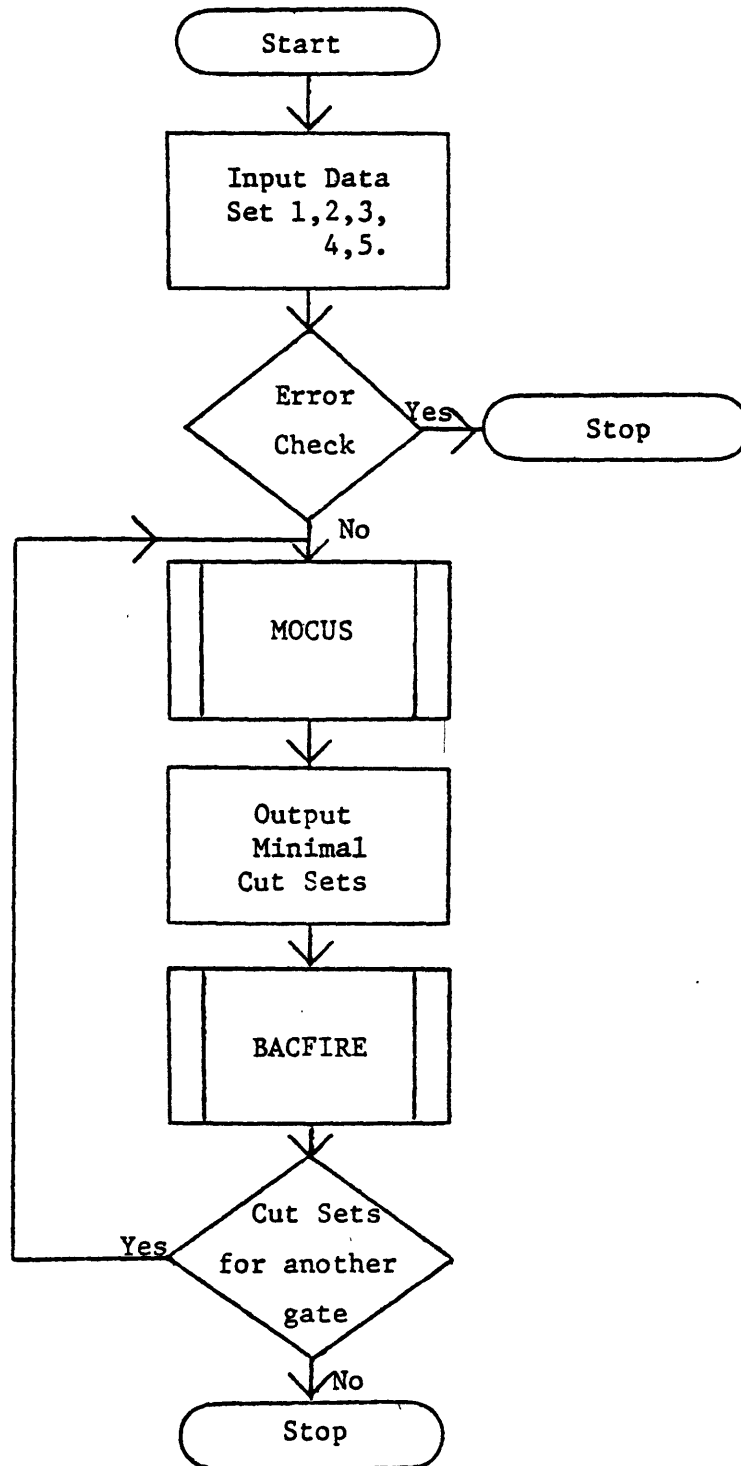


Figure III-1: MOCUS-BACFIRE Flow Diagram

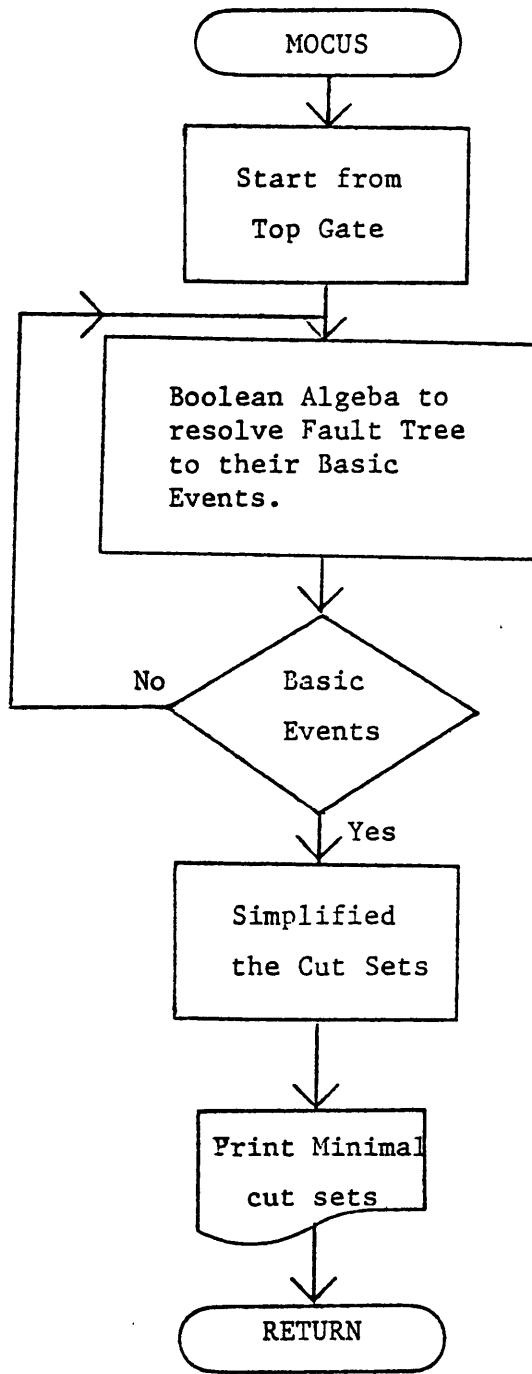


Figure III-2: MOCUS Flow Diagram

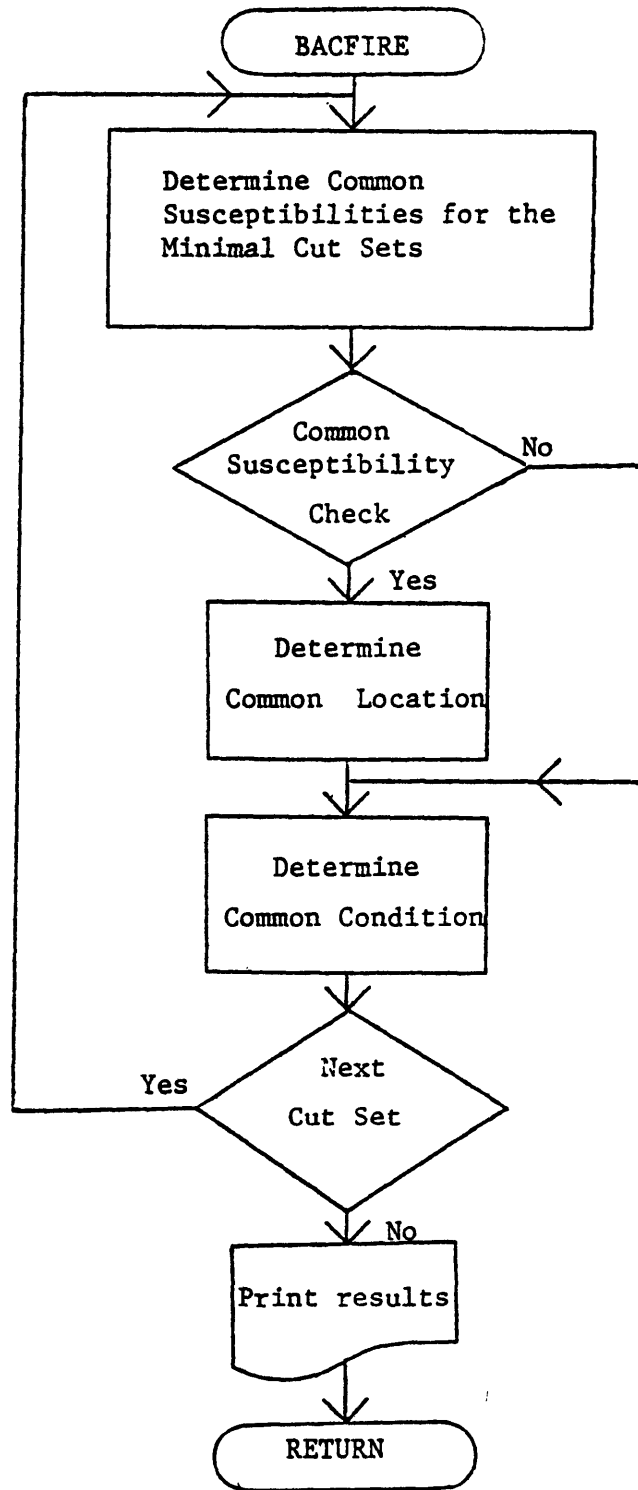


Figure III-3: BACFIRE Flow Diagram

Table III-1: Examples of Special Conditions for the First Criterion[4]

Symbol	Condition	Example Source
E	Energy source	Common drive shaft, same power supply
C	Calibration	Misprinted calibration instructions
I	Installations	Same subcontractor or crew contractor
M	Maintenance	Incorrect procedures, inadequately trained person
O	Operator or operation	Operator disabled or overstressed faulty operation procedures
P	Proximity	Location of all components of a cut set in one location
T	Test procedure	Faulty test procedures which may affect all components normally tested together
N	Energy flow paths	Location in same hydraulic loop, location in same electrical circuit

Table III-2: Example of Susceptibilities for the Second Criterion[4]

Symbol	Susceptibility	Example Source
Category I		
I	Impact	Pipe whip, water hammer, missiles, earthquakes, structural failure
V	Vibration	Machinery in motion, earthquake
P	Pressure	Explosion, pump overspeed, flow blockage
G	Grit	Dust, metal fragments
M	Moisture	Condensation, pipe rupture
S	Stress	Thermal stress at welds
T	Temperature	Fire, lightning, welding equipment, cooling system faults, electrical short circuit
F	Freezing	Liquid sodium solidifying, water freezing

Table III-2: ( continued )

Symbol	Susceptibility	Example Source
Category II		
E	Electromagnetic interference (EMI)	Welding equipment, rotating electrical machinery, lightning, power supplies, transmission lines
R	Radiation damage	Neutron sources, charged particle radiation
M	Conducting medium	Moisture, conductive gases
V	Out of tolerance voltage	Power surge
I	Out of tolerance current	Short circuit, power surge

Table III-2: ( continued )

Symbol	Susceptibility	Example Source
Category III		
A	Corrosion (acid)	Boric acid from neutron control system, acid used in maintenance for removing rust and cleansing
O	Corrosion (oxidation)	In a water medium or around high temperature metals
R	Other chemical reactions	Galvanic corrosion, complex interactions, actions of fuel cladding, water, oxide fuel, and fission products, leaching of carbon from stainless steel by sodium
C	Carbonization	Hydrocarbon in liquid sodium
B	Biological	Poisonous gases, explosions, missile hazards

#### IV. Input Description

Input to the MOCUS-BACFIRE package is similar to that of the MOCUS and BACFIRE codes. No change in the input format and the order in which data are input have been made. The input to the BACFIRE code is read in first and instead of data set five input to BACFIRE, which are the minimal cut sets, input data of the MOCUS fault tree are inserted.

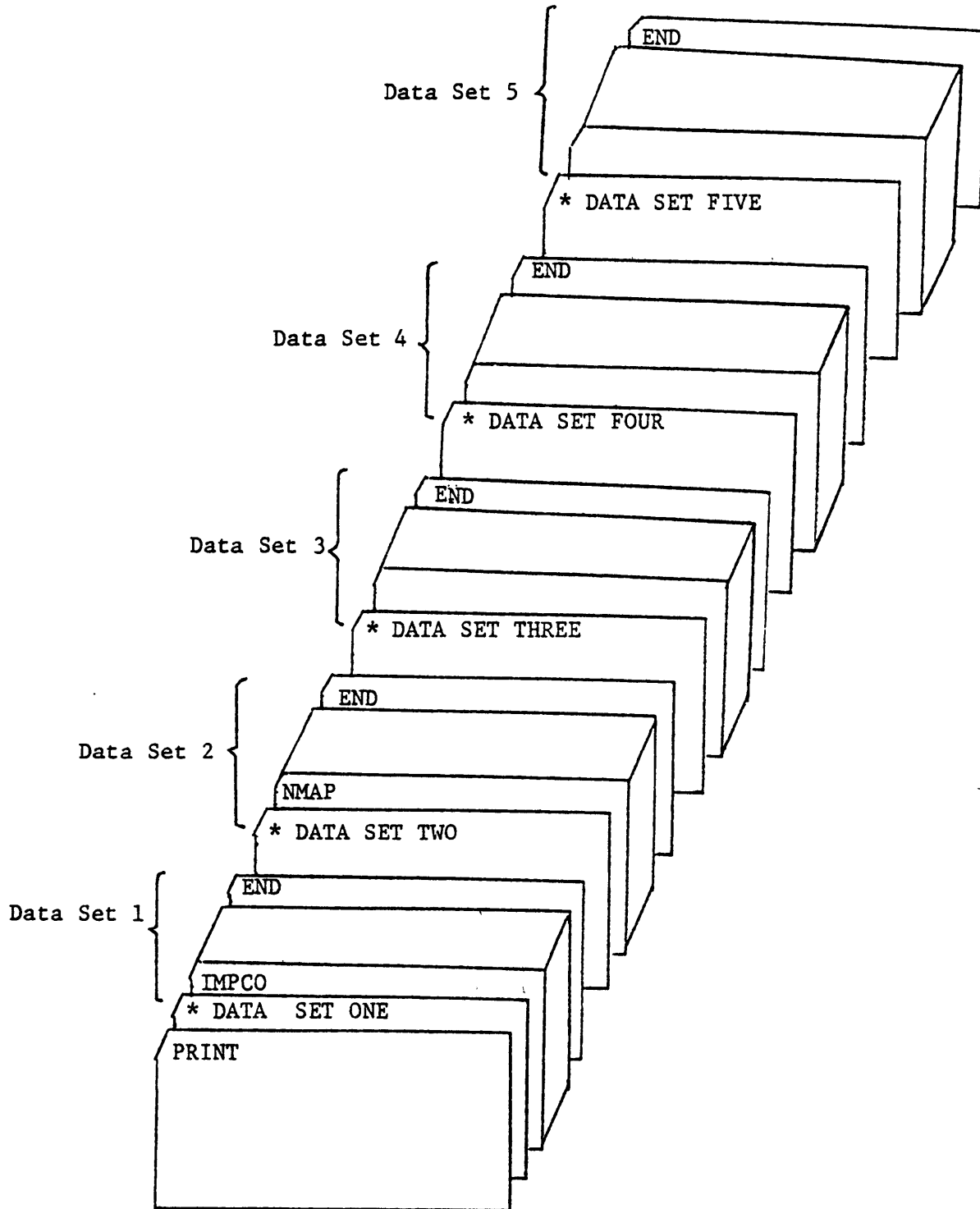
The information necessary for MOCUS-BACFIRE code consists of five data sets:

- 1) Event Definitions
- 2) Event Location References
- 3) Causes of Secondary Failure Library
- 4) Manufacturer Library
- 5) Fault Tree Description

Each data set is preceded by a card with an asterisk (\*) in column one and followed by a card with "END" in column one through three. The proper order of the data sets is shown in Figure IV-1. The input format will be discussed in order of submittal of the data sets.

An optional card preceding the first asterisk card is as follows: if "P" is punched in column one, the input data sets one through four will be printed as it is read by the programme. This print option is useful for determining errors in the programme input.

Figure IV-1: MOCUS-BACFIRE Input Data Sets



1. Data Set One: Event Definitions

The first set of input for MOCUS-BACFIRE defines each event by providing the event description, its location, causes of secondary failure and a relative ranking of the failure characteristics. An event definition must be supplied for each event that appears in the cut sets to be analyzed. Each event requires a minimum of two cards. The event data is coded according to the format in Table IV-1.

Minimum Sensitivity IMPCO: This data is supplied only once and on the card immediately following the asterisk card. IMPCO is used to restrict the analysis. The sensitivity ranking must be greater than or equal to IMPCO for each event in the minimal cut set for a common cause candidate to be printed. A blank card must be supplied if no minimum sensitivity is supplied.

Event Description C(I): Eight alphanumeric characters are used to identify a basic event. In Appendix A, details of an appropriate event naming scheme used during the Reactor Safety Study [2] are discussed. Any eight character event descriptions can be used, but it must be identical to the event descriptions used in the fault tree.

Manufacturer MFG(I): A special data location is supplied for a particular special condition which deserves special consideration, manufacturer related data. This category is checked based on the first criterion as are other special conditions. This variable is checked against data set four to identify the particular common special condition.

Location LO(I,1): The first position in this array stores the number of locations used in defining the event.

Table IV-1: Description of Input for Data Set One

FORTRAN Variables	Format	Column	Justification*
IMPCO	I5	1-5	right
( one set of the following cards for each basic event )			
Card 1. One card for each event definition			
C(I)	A8	1-8	left
MFG(I)	A1	44	
LO(I,1)	I4	47-50	right
GCS(I,J,K)			
Category 1	5A1	56-60	
Category 2	5A1	61-65	
Category 3	5A1	66-70	
Category 4	5A2	71-80	left
Card 2. One card for each event definition			
LO(I,2)	A4	47-50	left
IMP(I,J,K)			
Category 1	5I1	56-60	
Category 2	5I1	61-65	
Category 3	5I1	66-70	
Category 4	5I2	71-80	right
Card 3. One card for each additional event location			
LO(I,J)	A4	47-50	left

\* Setting the end of a string of characters or numbers against a specified margin.

Cause of secondary failure GCS(I,J,K): This array contains the qualitative failure characteristics assigned to each event in its respective category. There are three blocks for up to five one character codes in each of three cause of secondary failure susceptibility categories. The last block is for up to five two character codes from the fourth category for special conditions. The related sensitivity ranking of each failure characteristic is supplied in the same column as the susceptibility or condition on the data card immediately following it.

Location LO(I,2): This position in the LO array stores the first location identified with the basic event.

Sensitivity ranking IMP(I,J,K): The sensitivity ranking assigned to each failure characteristic is stored in this array and is input in the same column as the susceptibility or special condition on the card immediately following the event description card.

Location LO(I,J): These positions record any additional locations associated with a basic event. The cards are only supplied when more than one location has been identified for the basic event.

## 2. Data Set Two: Event Location References

This data block cross references the location of the event definition in the proper domain on the various cause of secondary failure maps. Table IY-2 contains the input description for data set two.

Location and domain LOC(I), MAP(I,J): Each event location identified in the event definition is identified again here. The location code, as it appears in the event definition is followed by the domain code for the domain as it appears on different maps.

Table IV-2: Description of Input for Data Set Two

FORTRAN Variables	Format	Column	Justification
NMAP	I5	1-5	right

One card for each location in Data Set One

LOC(I)	A4	11-14	left
MAP(I,1)	A4, 1X	16-19	left
MAP(I,2)	A4, 1X	21-26	left
.			
.			
.			
.			

3. Data Set Three: Cause of Secondary Failure Library

This library references susceptibility and special condition descriptions with the code, category and domain map which is applicable in the barriers. The input description for data set three is in Table IV-3.

Qualitative failure characteristic SUS(I,J): A 24 character description of each susceptibility and special condition is located in this array. This information is used to identify the common susceptibility at common special condition in the programme output.

Qualitative failure characteristic code ASSUS(I): This is the susceptibility and special condition code assigned the failure characteristics. These correspond to the susceptibilities and special conditions assigned the basic events to data set one.

Category CTG(I): This variable identifies the category of failure characteristics code. The same code can be used in as many different categories as necessary. It is necessary to specify the special condition code as being used in category four.

Map MP(I): This variable identifies the cause of secondary failure with the map used to represent its domain. For special conditions, no map is necessary and this field can be left blank.

Table IV-3: Description to Input for Data Set Three

---

FORTRAN Variables	Format	Column	Justification
----------------------	--------	--------	---------------

---

One card for each qualitative failure characteristic

SUS(I,J)	3A8	1-24	left
ASSUS(I)	A2	30-31	left
CTG(I)	I1	35	
MP(I)	I2	39-40	right

---

#### 4. Data Set Four: Manufacturer Library

This library serves the same purpose for a significant special condition as data set three. The numerous different possible manufacturers can create a long listing of their own. For these reasons, a separate data array and library were created for use in determining the common condition of manufacture. However, since this is checked by the first criterion, any significant special condition can be checked here. Coding on the event definitions is in Manufacturer MFG(I). A sensitivity of 9 is assigned a common cause candidate found by data set four. Description for the input to data set four is given in Table IV-4.

Manufacturer MANU(I,J): A 24 character description of the manufacturer is stored in this array. This information is used to identify the common special condition in the programme output.

Manufacturer code AMAN(J): This is the manufacturer code assigned the potential common cause of failure of manufacturer. These codes correspond to the manufacturer code assigned in data set one.

Table IV-4: Description for Input of Data Set Four

---

FORTTRAN Variables	Format	Column	Justification
One card per manufacturer			
MANU(I,J)	3A8	1-24	left
AMAN(I)	A1	30	

---

5. Data Set Five: Fault Tree Description

Data set five consists of four input groups:

- i) Control Information
- ii) Fault Tree Description
- iii) House Events
- iv) Gates for which Minimal Sets are to be found

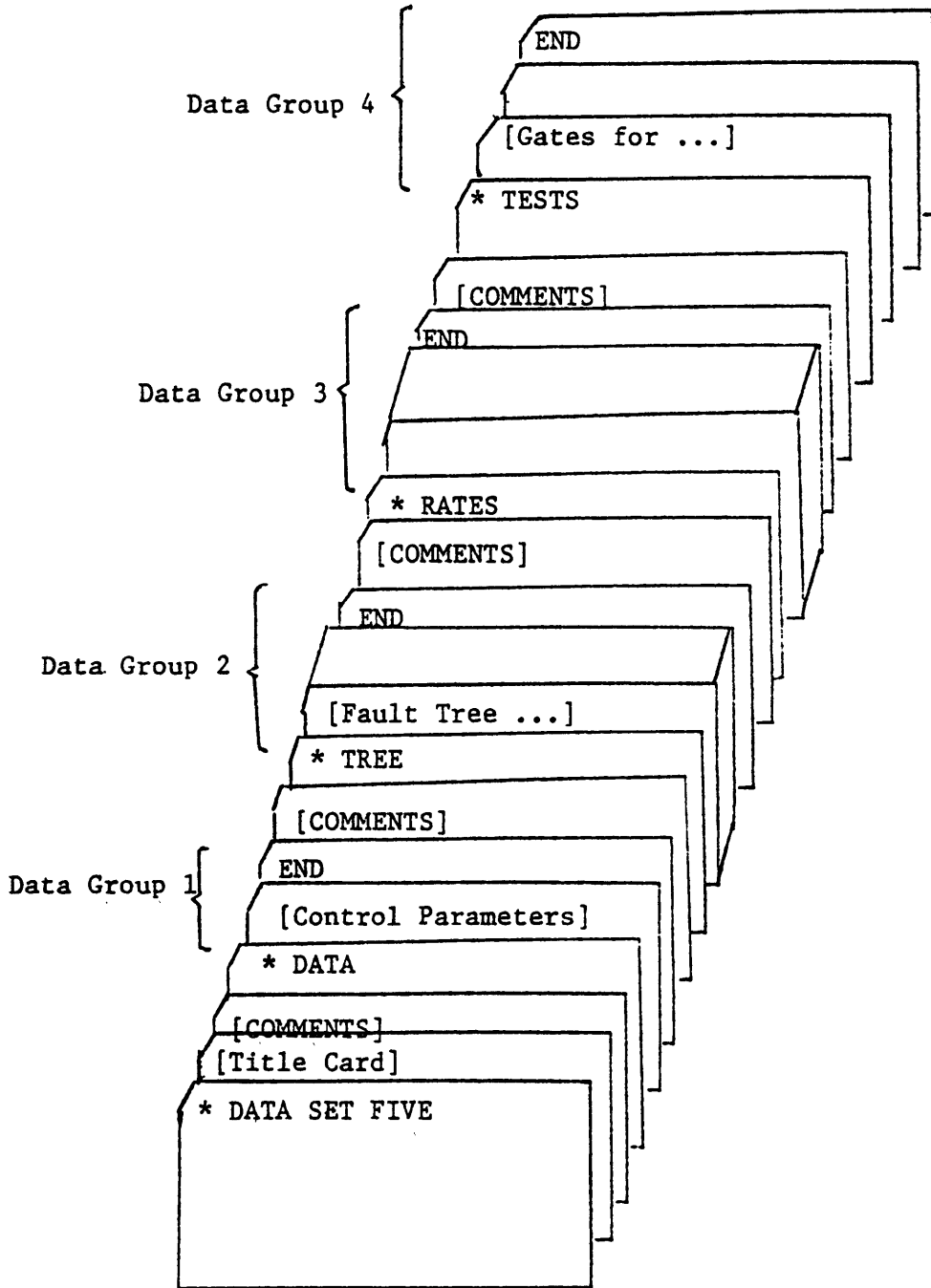
The beginning of each group of data is indicated by a special control card of the form:

Column 1	column 2	column 3
*	blank	KEYWORD

with KEYWORD replaced by DATA for input group 1  
TREE for input group 2  
RATES for input group 3  
TESTS for input group 4

The end of each input group is indicated by a card with the word "END" beginning in the first column. Each of these input groups may be preceded by any number of comment cards. The comments on the title card are printed on each page of the MOCUS output. The data set five deck setup is shown in Figure IV-2.

Figure IV-2: Input Deck Setup for Data Set Five



i) Input Group 1

Input group one contains the maximum length minimal cut sets to be found and switches to control the output. A description of the format for input group one is given in Table IV-5 and Table IV-6.

ii) Input Group 2

Information required for input group two is the name of each gate in the fault tree, its type, the number of inputs to it and the names of its inputs. The information is supplied one gate per card. A description of the format for input group two is given in Table IV-7 and Table IV-8.

Table IV-5: Description of Input Group 1

FORTRAN	Format	Column	Justification
Variables			
ITMAX	I5	1-5	right
IDEX1	A10	11-20	left
IDEX	A10	21-30	left

Table IV-6 Description of FORTRAN Variables of Input Group 2

FORTRAN	Description
Variables	
ITMAX	The maximum size of the minimal cut sets to be found.
IDEX	Switch that determines whether minimal cut sets or both minimal cut sets and path sets are to be found. If the word "CUT" is input for IDEX1, the minimal cut sets are determined. If the word "BOTH" is input, both the minimal cut sets and path sets are found.
IDEX2	Switch that determines whether the minimal sets are to be printed or punched or both. If the word "PRINT" is input, the minimal sets are printed. If the word "PUNCH" is input, the minimal sets are punched. If the word "BOTH" is input, the minimal sets are both printed and punched.

Table IV-7: Description of Input Group 2

FORTRAN Variables	Format	Column	Justification
( for each input card )			
GNAME	A8	1-8	left
GTYPE	A3	10-12	left
NGATE	I2	14-15	right
NCOMP	I2	16-17	right
GCN(1)	A8, 1X	19-26	left
GCN(2)	A8, 1X	28-35	left
GCN(3)	A8, 1X	37-44	left
GCN(4)	A8, 1X	46-53	left
GCN(5)	A8, 1X	55-62	left
GCN(6)	A8, 1X	64-71	left
GCN(7)	A8, 1X	73-80	left

Table IV-8: Description of FORTRAN Variables for Input Group 2

FORTRAN Variables	Description
GNAME	Gate name consists of any eight alphanumeric characters.
GTYPE	Gate type must be either an "AND" gate or "OR" gate.
NGATE	Number of gate inputs.
NCOMP	Number of components inputs.
GCN(I)	Input I name.

iii) Input Group 3 (optional)

Input group three is used to specify whether house events have a failure probability of zero ("off") or unity ("on"). The name of the house event, NAM(I) must be the same alphanumeric name as used in input group two. Table IV-9 shows the input format for the house events. Data for two house events can be included on one card. If the house event is "off", TAU(I) is set to 0.0 or left blank. If the house event is always failed TAU(I) is set to 1.0.

Table IV-9: Description for Input Group 3

FORTTRAN Variables	Format	Column	Justification
Two house events per card			
NAM(I)	A8, 12X	1-8	left
TAU(I)	F10.3, 1X	21-30	
NAM(I+1)	A8, 12X	31-38	left
TAU(I+1)	F10.3	51-60	

iv) Input Group 4 (optional)

Input group is optional, which specifies the gates for which minimal sets are to be found. One card is required for each gate. The gate alphanumeric name must be identical to that used in input group two. If no input group four data card is supplied, then the minimal sets specified in input group one are determined for the first gate described in input group two only. Up to twenty input group four cards can be supplied. The input format is shown in Table IV-10 and Table IV-11.

Table IV-10: Description of Input Group 4

FORTTRAN Variables	Format	Column	Justification
NGTE	A8, 2X	1-8	left
DUM1	A8	11-18	left

Table IV-11: Description of FORTRAN Variables for Input Group 4

FORTTRAN Variables	Description
NGTE	Alphanumeric name of gate for which minimal sets are to be found.
DUM1	Minimal set punch suppression flag. If DUM1 is any alphanumeric character ( other than blank ) the minimal sets for NGTE are not punched.

## V. Output Description

The output from MOCUS-BACFIRE contains:

- 1) The input data sets one through four if the PRINT option card is used.
- 2) BACFIRE code statistics.
- 3) MOCUS code input data edit and data set five fault tree description.
- 4) Minimal cut sets with common cause candidates and their failure commonalities that are ranked higher than IMPCO. The minimum, maximum, average and the sum of the sensitivity of the commonality are also listed for analyst reference.
- 5) A list of all qualitative failure characteristics input in data set three and data set four is printed. Following each potential cause of failure are the events identified by BACFIRE. These events represent the common cause candidates identified by the qualitative failure characteristics. The new cut set generated for common cause candidates identified by the first criterion consists of one event. Table V-1 contains the decoding information for the eight character event, The new cut set generated for common cause candidates identified by the second criterion also consists of one event. Table V-2 contains the decoding information for the event.

Table V-1: Decoding for First Criterion Cut Sets

Position	Description
1, 2	The failure characteristic code ( Table III-1 )
3	The category of the failure characteristic
	4 - special condition
	5 - manufacturer
4 - 6*	The common cause candidate number
8 - 10*	The minimal cut set number

Table V-2: Decoding for Second Criterion Cut Sets

Position	Description
1	The cause of secondary failure code ( Table III-2 )
2	The category of the cause of secondary failure
3	The minimum sensitivity ranking in the common cause candidate
4 - 6*	The common cause candidate number
8 - 10*	The minimal cut set number

\* The maximum number of common cause candidates and minimal cut sets printed are limited to 999.

VI. References

- [1] Mohammad Modarres, Norman C. Rasmussen, Lothar Wolf:  
"Reliability Analysis of Complex Technical Systems Using  
the Fault Tree Modularization Technique", MITNE-228, January  
1980. Department of Nuclear Engineering, MIT, Cambridge,  
Massachusetts 02139 USA.
  
- [2] "Reactor Safety Study", WASH-1400 (NUREG 75/014) U.S.  
Nuclear Regulatory Commission, October, 1975.
  
- [3] J.B. Fussell, E.B. Henry, N.H. Marshall: "MOCUS - A Computer  
Programme to Obtain Minimal Sets from Fault Tree", ANCR-1156,  
August, 1974. Available from National Technical Information  
Service, U.S. Department of Commerce, Springfield, Virginia  
22161, USA.
  
- [4] C.L. Cate, J.B. Fussell, "BACFIRE - A Computer Programme for  
Common Cause Failure Analysis" NERS-77-02, May, 1977. Nuclear  
Engineering Department, University of Tennessee, Knoxville,  
Tennessee 37916 USA.
  
- [5] R.E. Barlow, H.E. Lambert: "Introduction to Fault Tree Analysis"  
SIAM, 1975.

Appendix A: Basic Event Coding Information [2]

Event Naming

Each unique basic input event shown on the logic model is given a unique eight-character code name in order to facilitate proper evaluation of the logic model. For example, a component failure event may appear several places on a logic model and on more than one logic model, but if it is the component with the same failure mode, it will have the same name. The coding scheme identifies events by system, component type, component identification, and failure mode as shown below.

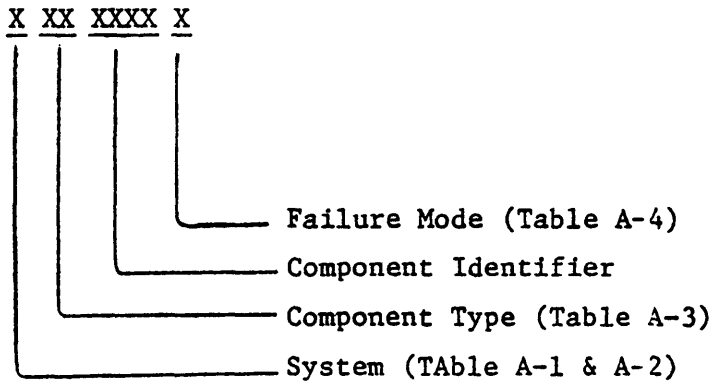


Table A-1: BWR System Identification Code

---

Code	System Name
1	Main Steam
2	Reactor Recirculation and Automatic Depressurization (ADS)
3	Reactor Protection System (RPS)
4	Feedwater
8	Offgas System
9	Vapour Suppression System (VSS)
A	Core Spray Injection System (CSIS)
B	Low Pressure Coolant Injection System (LPCIS)
C	Nuclear Boiler Vessel Instrumentation
D	High Pressure Service Water System (HPSWS)
E	Service Water
F	High Pressure Coolant Injection System (HPCIS)
L	Reactor Core Isolation Cooling System (RCICS)
M	Emergency Service Water System (ESWS)
N	Radwaste
Q	Electrical Power
R	Hydraulic Control Unit
S	Containment Leakage (CL)
U	Chilled Water
V	Standby Gas Treatment System (SBGTS)
X	Diesel Generator
Y	Containment Atmosphere Dilution System
Z	Reactor Building Heating and Ventilation
#	Fuel Pool

---

Table A-2: PWR System Identification Code

---

Code	System Name
A	Accumulator (ACC)
G	Containment Leakage (CL)
N	Consequence Limiting Control System (CLCS)
K	Containment Heat Removal System (CHRS)
C	Containment Spray Injection System (CSIS)
D	Containment Spray Recirculation System (CSRS)
J	Electrical Power (EPS)
F	High Pressure Injection System (HPIS)
H	High Pressure Recirculation System (HPRS)
B	Low Pressure Injection System (LPIS)
E	Low Pressure Recirculation System (LPRS)
L	Sodium Hydroxide Addition System (SHAS)
I	Reactor Protection System (RPS)
M	Safety Injection Control System (SICS)
P	Auxiliary Feedwater (AF)

---

Table A-3: Component Code

---

Mechanical Components

---

Accumulator	AC	Sluice Gate	SL
Blower	BL	Sump	SP
Control Rod Drive Unit	CD	Subtree	ST
Cover Plate	FA	Tank	TK
Damper	DM	Tubing	TG
Diesel	DL	Valve, Check	CV
Expansion Joint	XJ	Valve, Explosion Operated	EV
Filter or Strainer	FL	Valve, Hydraulic Operated	HV
Gas Bottle	GB	Valve, Manual	XV
Gasket	GK	Valve, Motor Operated	MV
Heat Exchanger	HE	Valve, Pneumatic Operated	AV
Nozzle	NZ	Valve, Relief	RV
Orifice	OR	Valve, Safety	SV
Pipe	PP	Valve, Solenoid Operated	KV
Pipe Cap	CP	Valve, Stop Check	DV
Pressure Vessel	PV	Valve, Vacuum Relief	VV
Pump	PM	Turbine	TB
Reactor Control Rod	ED	Vent	VT
Refrigeration Unit	RF	Well	WL

---

Table A-3: ( continued )

---

Electrical Components

---

Amplifier	AM	Ground Switch	GS
Annunciator	AN	Relay	RE
Battery	BY	Relay or Switch Contact	CN
Battery Charger	BC	Reset Switch	RS
Bus	BS	Resistor, Temperature Device	RT
Cable	CA	Signal Comparator	AD
Circuit Breaker	CB	Switch, Pressure	PS
Clutch	CL	Switch, Torque	QS
Control Switch	CS	Switch, Temperature	TS
Coil	CO	Terminal Board	TM
Detector	DI	Diode or Rectifier	DE
DC Power Supply	DC	Fuse	FU
Flow Switch	FS	Generator	GE
Heating Element	HG	Heat Tracing	HT
Input Module	IM	Test Pushbutton	SB
Inverter (solid state)	IV	Thermal Overload	OL
Level Switch	ES	Timer	TI
Light	LT	Transformer, Current	CT
Limit Switch	LS	Transformer, Potential	TR
Manual Switch	SW	Transformer, Power	TR
Motor	MO	Transmitter, Flow	TF
Motor Starter	MS	Transmitter, Level	TL
Neutron Detector	ND	Transmitter, Pressure	TP
Potentiometer	PT	Transmitter, Temperature	TT
Recorder	RC	Wire	WR
Lightning Arrestor	LA	Event (no component involved)	00

---

Table A-4: Failure Mode Code

---

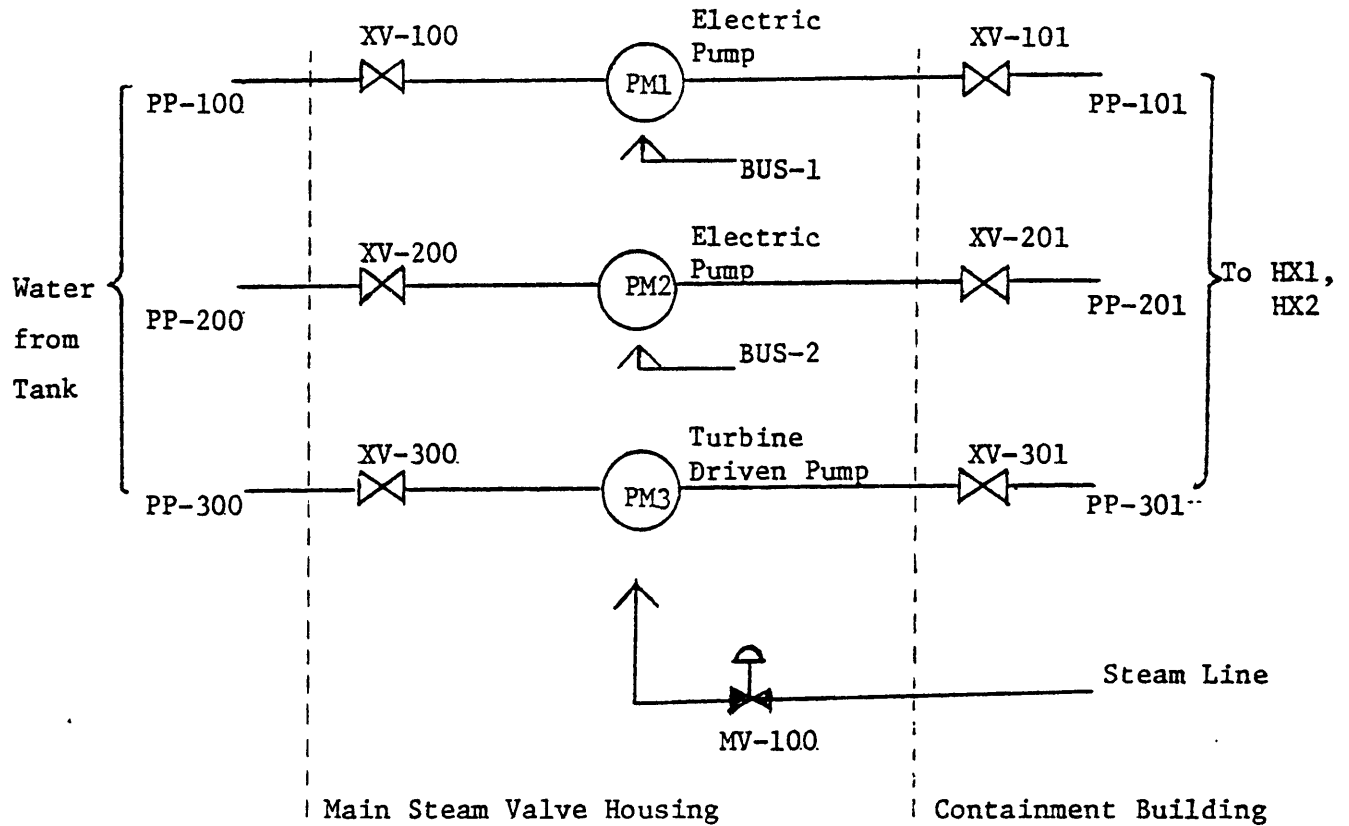
Failure Name	
Closed	C
Disengaged	G
Does not close	K
Does not open	D
Engaged	E
Does not start	A
Exceeds limit	M
Leakage	L
Loss of function	F
Maintenance fault	Y
No input	N
Open	O
Open circuit	B
Operational fault	X
Overload	H
Plugged	P
Rupture	R
Short circuit	Q
Short to ground	S
Fault transfer	T

Appendix B: Sample Problem Description

This example problem for the MOCUS-BACFIRE common cause analysis code was taken from the Reactor Safety Study [2] PWR Auxiliary Feedwater System. Figure B-1 is a simplified flow diagram of the Auxiliary Feedwater System. The system description can be found in the Reactor Safety Study Appendix II [2].

Figure B-2 is the system fault tree for the top event - "Insufficient Auxiliary Feedwater to At Least One Heat Exchanger On Demand". The components along with their generic cause susceptibilities are listed in Table B-1. Also contained in this table are the physical locations of the components which correspond to the floor plan of Figure B-3. Some components are identified in more than one location, such as wiring or piping which may pass through various barriers.

Figure B-4 shows the three susceptibility maps used in the analysis. Table B-2 indicates which maps are used for different susceptibilities. The areas on these maps are the various domains for these causes of secondary failure. The domain data is tabulated in Table B-2.



- XV Manual Valve
- MV Motor Operated Valve
- PP Pipe
- TK Tank
- HX Heat Exchanger
- SL Steam Line

Figure B-1: Sample Problem Flow Diagram (PWR Auxiliary Feedwater System)

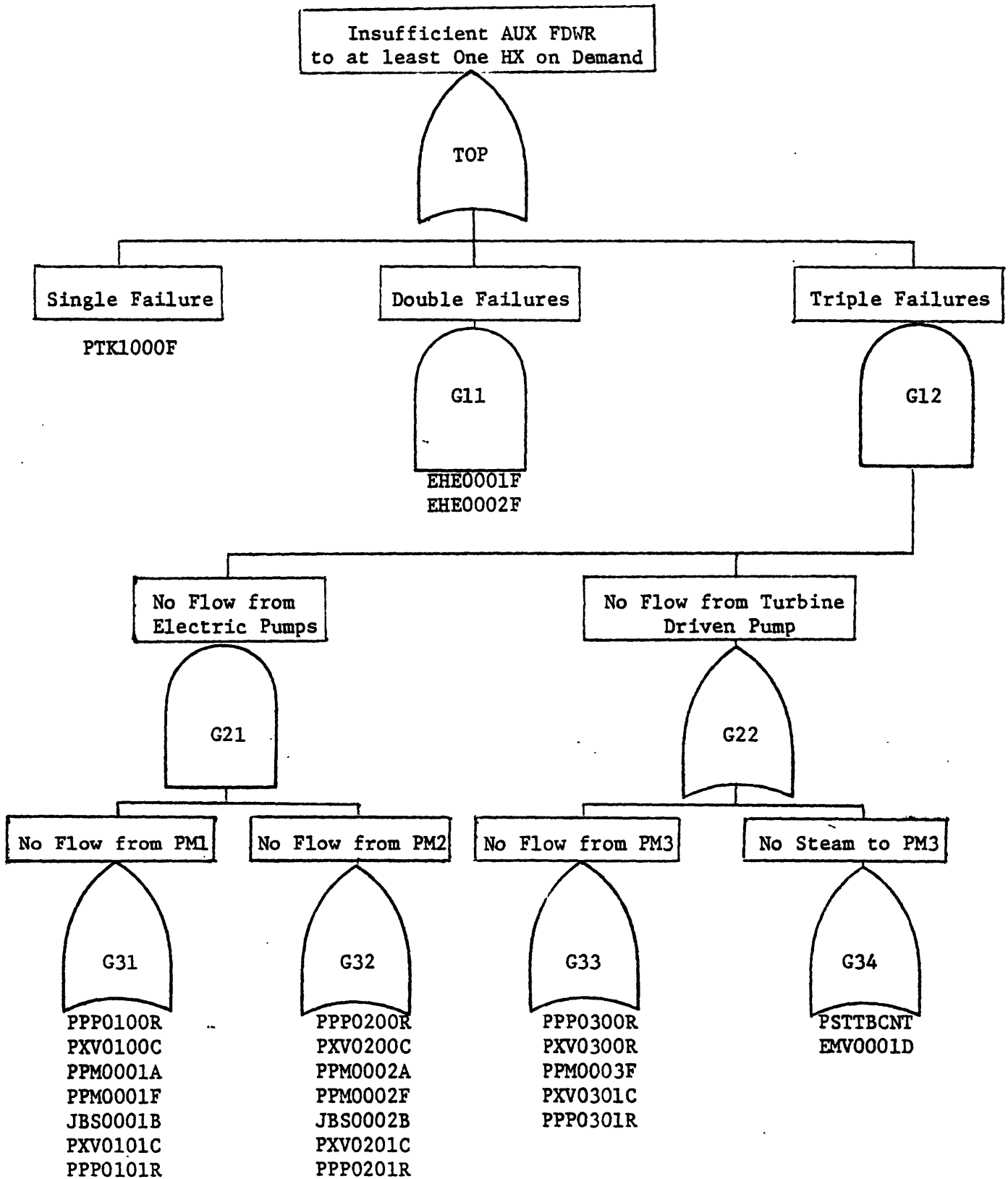


Figure B-2: Sample Problem Fault Tree

Figure B-3: Floor Map

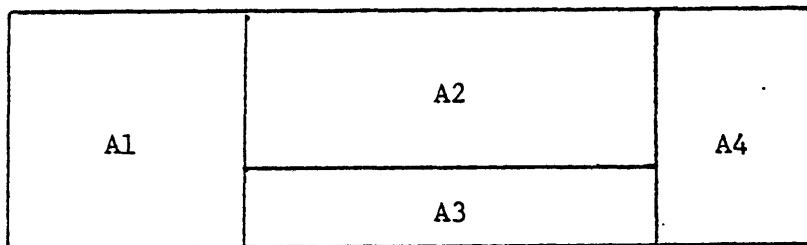
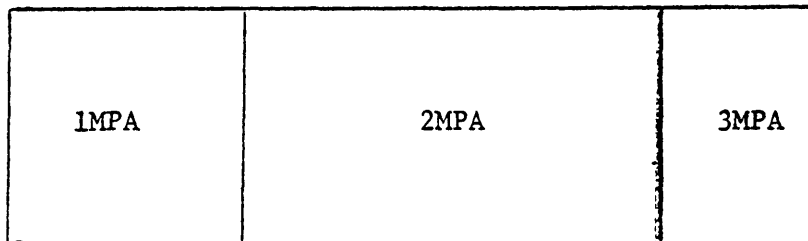
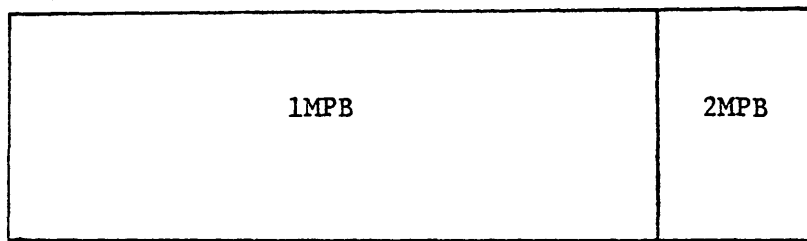


Figure B-4: Susceptibility Maps

MAP - A



MAP - B



MAP - C

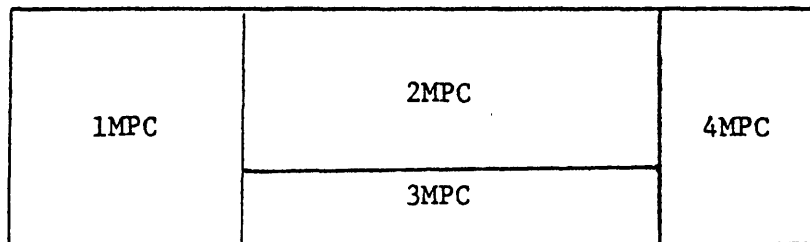


Table B-1 Common Cause Failure Data for the Sample Problem

Basic Event	Physical Location	Qualitative Failure Characteristics	
		Generic Cause Susceptibility (Category 1)	Special Conditions (Category 4)
PTK1000F	A1	I, U, P, S	M1, N1, N2, N3
EHE0001F	A4	I, U, P, S, T	M3, N4
EHE0002F	A4	I, U, P, S, T	M3, N4
PPP0100R	A1, A2	I, U, P, S, T	M2, N1, T1
PXV0100C	A2	I, U, P, S, T	M2, N1, T1
PPM0001A	A2	I, U, P, S	M1, N1, T1, E1
PPM0001F	A2	I, U, P, S, T	M1, N1, T1, E1
JBS0001B	A2	I, S, T, C	M3, N1, T1
PPP0101R	A2, A4	I, U, P, S, T	M3, N1, T1
PPP0200R	A1, A2	I, U, P, S, T	M2, N2, T2
PXV0200C	A2	I, U, P, S, T	M2, N2, T2
PPM0002A	A2	I, U, P, S	M1, N2, T2, E2
PPM0002F	A2	I, U, P, S, T	M1, N2, T2, E2
JBS0002B	A2	I, S, T, C	M2, E2, T2
PXV0201C	A2	I, U, P, S, T	M3, N2, T2
PPP0201R	A2, A4	I, U, P, S, T	M3, N2, T2
PPP0300R	A1, A3	I, U, P, S, T	M2, N3, T3
PXV0300C	A3	I, U, P, S, T	M2, N3, T3
PPM0003F	A3	I, U, P, S, T	M1, N3, T3
PXV0301C	A3	I, U, P, S, T	M3, N3, T3
PPP0301R	A3, A4	I, U, P, S, T	M3, N2, T3
PSTTBCNT	A3, A4	I, U, P, S	M3, N4, T3
EMV0001D	A3	I, U, P, S, T	M1, N4, T3, E3

Table B-2: Generic Cause Susceptibility Domain for the Sample Problem

Generic Cause	Domain	Physical Location
I, S, T, G, M	1MPA	A1
A, O, R	2MPA	A2, A3
	3MPA	A4
V	1MPB	A1, A2, A3
	2MPB	A4
P, C	1MPC	A1
	2MPC	A2
	3MPC	A3
	4MPC	A4

Appendix C

Sample Programme Job Control Language  
for IBM 370/168 (OS/VS1) at MIT

```
// PROFILE='LOW, MEMORY=500'  
// *PASSWORD ?  
// EXEC FTG1XEQ, PROG='RACHEL.MOCUS.BACFR.LOAD1(NELIB)'  
// LKED.SYSLMOD DD UNIT=2314, VOL=(PRIVATE, RETAIN, SER=234019), DISP=SHR  
// GO.FT10F001 DD DCB=(RECFM=VB, LRECL=84, BLKSIZE=1684), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT10F002 DD DCB=(RECFM=VB, LRECL=84, BLKSIZE=1684), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT10F003 DD DCB=(RECFM=VB, LRECL=84, BLKSIZE=1684), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT10F004 DD DCB=(RECFM=VB, LRECL=84, BLKSIZE=1684), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT14F001 DD DCB=(RECFM=VBS, BLKSIZE=1600), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT15F001 DD DCB=(RECFM=VBS, BLKSIZE=1600), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT16F001 DD DCB=(RECFM=VBS, BLKSIZE=1600), UNIT=SYSDA,  
// SPACE=(TRK,(5,2))  
// GO.FT08F001 DD DUMMY  
// GO.FT09F001 DD DUMMY  
// GO.FT11F001 DD DCB=(RECFM=FB, LRECL=20, BLKSIZE=3120), UNIT=SYSDA,  
// SPACE=(TRK,(100,100))  
// GO.FT12F001 DD DCB=(RECFM=FB, LRECL=20, BLKSIZE=3120), UNIT=SYSDA,  
// SPACE=(TRK,(100,100))  
// GO.SYSIN DD *  
// *INSERT ?  
/*
```

## Appendix D

### Sample Problem Input

PRINT INPUT DATA  
\* DATA SET ONE

5

PTK1000F	T	1	IUPS	OR	M1N1N2N3
	A1		5432	43	02010101
EHE0001F	H	1	IUPST	AOR	N4
	A4		23432	678	08
EHE0002F	H	1	IUPST	AOR	N4
	A4		23432	678	08
PPP0100R	P	2	IUPST	AOR	N1M2T1
	A1		65432	213	050201
	A2				
PXV0100C	V	1	IUPSTG	AR	N1M2T1
	A2		543213	33	020304
PPM0001A	U	1	IUPS GM	AOR	N1M1T1E1
	A2		1234 32	331	02030405
PPM0001F	U	1	IUPSTGM	AOR	N1M1T1E1
	A2		5432532	332	02030405
JBS0001B	E	1	ISTC	AOR	E1M1T1
	A2		4334	555	010203
PXV0101C	V	1	IUPSTG	AR	N1M3T1
	A2		543213	33	020304
PPP0101R	P	2	IUPST	AOR	N1M3T1
	A2		65432	213	050201
	A4				
PPP0200R	P	2	IUPST	AOR	N2M2T2
	A1		65432	213	050201
	A2				
PXV0200C	V	1	IUPSTG	AR	N2M2T2
	A2		543213	33	020304
PPM0002A	U	1	IUPS GM	AOR	N2M1T2E2
	A2		1234 32	331	02030405
PPM0002F	U	1	IUPSTGM	AOR	N2M1T2E2
	A2		5432532	332	02030405
JBS0002B	E	1	ISTC	AOR	E2M1T2
	A2		4334	555	010203
PXV0201C	V	1	IUPSTG	AR	N2M3T2
	A4		543213	33	020304
PPP0201R	P	2	IUPST	AOR	N2M3T2
	A2		65432	213	050201
	A4				
PPP0300R	P	2	IUPST	AOR	N3M2T3
	A1		65432	213	050201
	A3				
PXV0300C	V	1	IUPSTG	AR	N3M2T3
	A3		543213	33	020304
PPM0003F	U	1	IUPSTGM	AOR	N3M1T3
	A3		5432532	331	020304
PXV0301C	V	1	IUPSTG	AR	N3M3T3
	A4		543213	33	020304
PPP0301R	P	2	IUPST	AOR	N2M3T3
	A3		65432	213	050201
	A4				
PSTTBCNT	P	2	IUPST	AOR	N4M3T3
	A3		65432	213	040302

EMV0001D

V A4 1 IUPSTGM AOR N4M1T3E3  
 A3 5432132 332 02030405

END

\* DATA SET TWO

3

A1 1MPA 1MPB 1MPC  
 A2 2MPA 1MPB 2MPC  
 A3 2MPA 1MPB 3MPC  
 A4 3MPA 2MPB 4MPC

END

\* DATA SET THREE

IMPACT	I	1	1
VIBRATION	U	1	2
PRESSURE	P	1	3
STRESS	S	1	1
TEMPERATURE	T	1	1
CURRENT	C	1	3
GRIT	G	2	1
MOISTURE	M	2	1
CORROSION (ACID)	A	3	1
CORROSION (OXIDATION)	O	3	1
CHEMICAL REACTION	R	3	1
HYDRAULIC LOOP - 1	N1	4	
HYDRAULIC LOOP - 2	N2	4	
HYDRAULIC LOOP - 3	N3	4	
HYDRAULIC LOOP - 4	N4	4	
POWER SUPPLY - 1	E1	4	
POWER SUPPLY - 2	E2	4	
POWER SUPPLY - 3	E3	4	
MAINTENANCE PROCEDURE 1	M1	4	
MAINTENANCE PROCEDURE 2	M2	4	
MAINTENANCE PROCEDURE 3	M3	4	
MAINTENANCE PROCEDURE 4	M4	4	
TEST PROCEDURE - 1	T1	4	
TEST PROCEDURE - 2	T2	4	
TEST PROCEDURE - 3	T3	4	

END

\* DATA SET FOUR

MANUFACTURER - T	T
MANUFACTURER - V	V
MANUFACTURER - P	P
MANUFACTURER - U	U
MANUFACTURER - H	H
MANUFACTURER - E	E

END

\* DATA SET FIVE - FAULT TREE INPUT  
 A SAMPLE PROGRAMME - PWR AUXFW SYSTEM

\* DATA

5 CUT PRINT

END

FAULT TREE DESCRIPTION

\* TREE

TOP OR 2 1 G11 G12 PTK1000F  
 G11 AND 0 2 EHE0001F EHE0002F

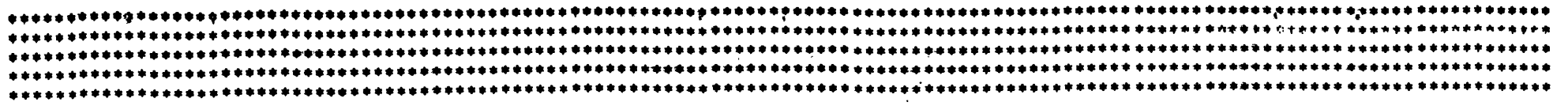
G12 AND 2 0 G21 G22  
G21 AND 2 0 G31 G32  
G22 OR 2 0 G33 G34  
G31 OR 0 7 PPP0100R PXV0100C PPM0001A PPM0001F JBS0001B PXV0101C PPP0101R  
G32 OR 0 7 PPP0200R PXV0200C PPM0002A PPM0002F JBS0002B PXV0201C PPP0201R  
G33 OR 0 5 PPP0300R PXV0300C PPM0003F PXV0301C PPP0301R  
G34 OR 0 2 PSTTBCNT EMV0001D

END  
THE GATE(S) FOR WHICH THE MINIMUM SETS ARE TO BE FOUND

\* TESTS

TOP

END



Appendix E

Sample Problem Output



A1	1MPA	1MPB	1MPC
A2	2MPA	1MPB	2MPC
A3	2MPA	1MPB	3MPC
A4	3MPA	2MPB	4MPC

IMPACT	I	1	1
VIBRATION	U	1	2
PRESSURE	P	1	3
STRESS	S	1	1
TEMPERATURE	T	1	1
CURRENT	C	1	3
GRIT	G	2	1
MOISTURE	M	2	1
CORROSION (ACID)	A	3	1
CORROSION (OXIDATION)	O	3	1
CHEMICAL REACTION	R	3	1
HYDRAULIC LOOP - 1	N1	4	0
HYDRAULIC LOOP - 2	N2	4	0
HYDRAULIC LOOP - 3	N3	4	0
HYDRAULIC LOOP - 4	N4	4	0
POWER SUPPLY - 1	E1	4	0
POWER SUPPLY - 2	E2	4	0
POWER SUPPLY - 3	E3	4	0
MAINTENANCE PROCEDURE 1	M1	4	0
MAINTENANCE PROCEDURE 2	M2	4	0
MAINTENANCE PROCEDURE 3	M3	4	0
MAINTENANCE PROCEDURE 4	M4	4	0
TEST PROCEDURE - 1	T1	4	0
TEST PROCEDURE - 2	T2	4	0
TEST PROCEDURE - 3	T3	4	0

MANUFACTURER - T	T
MANUFACTURER - V	V
MANUFACTURER - P	P
MANUFACTURER - U	U
MANUFACTURER - H	H
MANUFACTURER - E	E

```
* * * * *  
*          BACFIRE --- A PROGRAM TO OBTAIN COMMON CAUSE CANDIDATES          *  
* * * * *
```

```
NUMBER OF EVENTS WITH THEIR LOCATIONS AND GCS'S - - - - 24  
NUMBER OF MAPS USED - - - - - 3  
NUMBER OF LOCATIONS AND THEIR MAP LOCATIONS - - - - - 4  
NUMBER OF GCS'S - - - - - 25  
NUMBER OF MANUFACTURERS - - - - - 6  
SENSITIVITY CUT OFF - - - - - 5
```

\*\*\*\*\*  
COMMON CAUSE CANDIDATES  
\*\*\*\*\*

```

* * * * *
- - - - -
*
- MOCUS - - A COMPUTER PROGRAM TO OBTAIN MINIMAL SETS FROM FAULT TREES -
*
- - - - -
* * * * *
    
```

MOCUS INPUT EDIT

A SAMPLE PROGRAMME - PWR AUXFW SYSTEM

\* DATA

5 CUT PRINT

END

FAULT TREE DESCRIPTION

\* TREE

```

TOP      OR   2 1 G11      G12      PTK1000F
G11      AND  0 2 EHE0001F EHE0002F
G12      AND  2 0 G21      G22
G21      AND  2 0 G31      G32
G22      OR   2 0 G33      G34
G31      OR   0 7 PPP0100R PXV0100C PPM0001A PPM0001F JBS0001B PXV0101C PPP0101R
G32      OR   0 7 PPP0200R PXV0200C PPM0002A PPM0002F JBS0002B PXV0201C PPP0201R
G33      OR   0 5 PPP0300R PXV0300C PPM0003F PXV0301C PPP0301R
G34      OR   0 2 PSTTBCNT EMV0001D
    
```

END

THE GATE(S) FOR WHICH THE MINIMUM SETS ARE TO BE FOUND

\* TESTS

TOP

END

A SAMPLE PROGRAMME - PWR AUXFW SYSTEM

NUMBER OF GATES, NG----- 9  
NUMBER OF COMPONENTS, NI----- 24  
MAXIMUM SIZE OF SETS, ITMAX----- 5  
CUT SET - PATH SET SWITCH, IDEX1-----CUT  
PRINT - PUNCH SWITCH, IDEX2-----PRINT

A SAMPLE PROGRAMME - PWR AUXFW SYSTEM

MOCUS - - VERSION 3/74

NAME	TYPE	INPUTS----
TOP	OR	2 1 C11 G12 PTK1000F
G11	AND	0 2 EHE0001F EHE0002F
G12	AND	2 0 G21 G22
G21	AND	2 0 G31 G32
G22	OR	2 0 G33 G34
G31	OR	0 7 PPP0100R PXV0100C PPM0001A PPM0001F JBS0001B PXV0101C PPP0101R
G32	OR	0 7 PPP0200R PXV0200C PPM0002A PPM0002F JBS0002B PXV0201C PPP0201R
G33	OR	0 5 PPP0300R PXV0300C PPM0003F PXV0301C PPP0301R
G34	OR	0 2 PSTTBCNT EMV0001D

\*\*\*\*\*  
 MINIMAL CUT SETS FOR GATE TOP  
 \*\*\*\*\*

CUT SETS WITH 1 COMPONENTS

- 1) PTK1000F

CUT SETS WITH 2 COMPONENTS

- 2 1) EHE0001F EHE0002F

- 1) EHE0001F EHE0002F

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
HYDRAULIC LOOP - 4		8	8	8	16
MANUFACTURER - H		9	9	9	18
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
CORROSION (ACID)		6	6	6	12
CORROSION (OXIDATION)		7	7	7	14
CHEMICAL REACTION		8	8	8	16

CUT SETS WITH 3 COMPONENTS

- 3 1) PPP0100R PPP0300R PPP0200R

- 2) PPP0100R PPP0300R PPP0200R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

- 2) PXV0100C PPP0300R PPP0200R

3) PXV0100C PPP0300R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3) PPM0001A PPP0300R PPP0200R

4) PPM0001F PPP0300R PPP0200R

4) PPM0001F PPP0300R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

5) JBS0001B PPP0300R PPP0200R

6) PXV0101C PPP0300R PPP0200R

5) PXV0101C PPP0300R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

7) PPP0101R PPP0300R PPP0200R

6) PPP0101R PPP0300R PPP0200R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

8) PPP0100R PSTTBCNT PPP0200R

7) PPP0100R PSTTBCNT PPP0200R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

9) PPP0100R PXV0300C PPP0200R

8) PPP0100R PXV0300C PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

10) PPP0100R PPM0003F PPP0200R

9) PPP0100R PPM0003F PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

11) PPP0100R PXV0301C PPP0200R

12) PPP0100R PPP0301R PPP0200R

10) PPP0100R PPP0301R PPP0200R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM

IMPACT  
VIBRATION

6 6 6 18  
5 5 5 15

3

13) PXV0100C PSTTBCNT PPP0200R

11) PXV0100C PSTTBCNT PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 6 5 17

3

14) PXV0100C PXV0300C PPP0200R

12) PXV0100C PXV0300C PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 6 5 16

3

15) PXV0100C PPM0003F PPP0200R

13) PXV0100C PPM0003F PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 6 5 16

3

16) PXV0100C PXV0301C PPP0200R

3

17) PXV0100C PPP0301R PPP0200R

14) PXV0100C PPP0301R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 6 5 17

18) PPM0001A PSTTBCNT PPP0200R

3  
3  
3  
3  
3  
3  
3

PPM0001A PXV0300C PPP0200R

20) PPM0001A PPM0003F PPP0200R

21) PPM0001A PXV0301C PPP0200R

22) PPM0001A PPP0301R PPP0200R

23) PPM0001F PSTTBCNT PPP0200R

15) PPM0001F PSTTBCNT PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3

24) PPM0001F PXV0300C PPP0200R

16) PPM0001F PXV0300C PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3

25) PPM0001F PPM0003F PPP0200R

17) PPM0001F PPM0003F PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3

26) PPM0001F PXV0301C PPP0200R

3

27) PPM0001F PPP0301R PPP0200R

18) PPM0001F PPP0301R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3

28) JBS0001B PSTTBCNT PPP0200R

3

29) JBS0001B PXV0300C PPP0200R

3

30) JBS0001B PPM0003F PPP0200R

3

31) JBS0001B PXV0301C PPP0200R

3

32) JBS0001B PPP0301R PPP0200R

3

33) PXV0101C PSTTBCNT PPP0200R

19) PXV0101C PSTTBCNT PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
---	-------	-----	-----	-----	-----

IMPACT

5

6

5

17

3

34) PXV0101C PXV0300C PPP0200R

20) PXV0101C PXV0300C PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

16

3

35) PXV0101C PPM0003F PPP0200R

21) PXV0101C PPM0003F PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

16

3

36) PXV0101C PXV0301C PPP0200R

## CUT SETS WITH 3 COMPONENTS

3

37) PXV0101C PPP0301R PPP0200R

22) PXV0101C PPP0301R PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

3

38) PPP0101R PSTTBCNT PPP0200R

23) PPP0101R PSTTBCNT PPP0200R

COMMON CONDITION -- FIRST CRITERION

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

MANUFACTURER - P

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	6	6	6	18
	5	5	5	15

IMPACT

VIBRATION

3

39) PPP0101R PXV0300C PPP0200R

24) PPP0101R PXV0300C PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

3

40) PPP0101R PPM0003F PPP0200R

25) PPP0101R PPM0003F PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

3

41) PPP0101R PXV0301C PPP0200R

3

42) PPP0101R PPP0301R PPP0200R

26) PPP0101R PPP0301R PPP0200R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

3 43) PPP0100R EMV0001D PPP0200R

27) PPP0100R EMV0001D PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 44) PXV0100C EMV0001D PPP0200R

28) PXV0100C EMV0001D PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 45) PPM0001A EMV0001D PPP0200R

3 46) PPM0001F EMV0001D PPP0200R

29) PPM0001F EMV0001D PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3  
3  
JBS0001B EMV0001D PPP0200R  
48) PXV0101C EMV0001D PPP0200R

30) PXV0101C EMV0001D PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3  
49) PPP0101R EMV0001D PPP0200R

31) PPP0101R EMV0001D PPP0200R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3  
50) PPP0100R PPP0300R PXV0200C

32) PPP0100R PPP0300R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3  
51) PPP0100R PPP0300R PPM0002A

3  
52) PPP0100R PPP0300R PPM0002F

33) . PPP0100R PPP0300R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3  
53) PPP0100R PPP0300R JBS0002B

3  
54) PPP0100R PPP0300R PXV0201C

55) PPP0100R PPP0300R PPP0201R

34) PPP0100R PPP0300R PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

56) PXV0100C PPP0300R PXV0200C

35) PXV0100C PPP0300R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

57) PXV0100C PPP0300R PPM0002A

58) PXV0100C PPP0300R PPM0002F

36) PXV0100C PPP0300R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

59) PXV0100C PPP0300R JBS0002B

60) PXV0100C PPP0300R PXV0201C

61) PXV0100C PPP0300R PPP0201R

37) PXV0100C PPP0300R PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

62) PPM0001A PPP0300R PXV0200C

63) PPM0001A PPP0300R PPM0002A

64) PPM0001A PPP0300R PPM0002F

65) PPM0001A PPP0300R JBS0002B

66) PPM0001A PPP0300R PXV0201C

67) PPM0001A PPP0300R PPP0201R

68) PPM0001F PPP0300R PXV0200C

PPM0001F PPP0300R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 69) PPM0001F PPP0300R PPM0002A

3 70) PPM0001F PPP0300R PPM0002F

39) PPM0001F PPP0300R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 71) PPM0001F PPP0300R JBS0002B

3 72) PPM0001F PPP0300R PXV0201C

3 73) PPM0001F PPP0300R PPP0201R

40) PPM0001F PPP0300R PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 74) JBS0001B PPP0300R PXV0200C

3 75) JBS0001B PPP0300R PPM0002A

3 76) JBS0001B PPP0300R PPM0002F

3 77) JBS0001B PPP0300R JBS0002B

3 78) JBS0001B PPP0300R PXV0201C

3 79) JBS0001B PPP0300R PPP0201R

3 80) PXV0101C PPP0300R PXV0200C

41) PXV0101C PPP0300R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
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IMPACT

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16

3  
3

81) PXV0101C PPP0300R PPM0002A

82) PXV0101C PPP0300R PPM0002F

42) PXV0101C PPP0300R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

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16

3  
3  
3

83) PXV0101C PPP0300R JBS0002B

84) PXV0101C PPP0300R PXV0201C

85) PXV0101C PPP0300R PPP0201R

43) PXV0101C PPP0300R PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

17

3

86) PPP0101R PPP0300R PXV0200C

44) PPP0101R PPP0300R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

17

3  
3

87) PPP0101R PPP0300R PPM0002A

88) PPP0101R PPP0300R PPM0002F

45) PPP0101R PPP0300R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

17

3 89) PPP0101R PPP0300R JBS0002B  
3 90) PPP0101R PPP0300R PXV0201C  
3 91) PPP0101R PPP0300R PPP0201R

46) PPP0101R PPP0300R PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

CUT SETS WITH 3 COMPONENTS

3 92) PPP0100R PSTTBCNT PXV0200C

47) PPP0100R PSTTBCNT PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 93) PPP0100R PSTTBCNT PPM0002A

3 94) PPP0100R PSTTBCNT PPM0002F

48) PPP0100R PSTTBCNT PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 95) PPP0100R PSTTBCNT JBS0002B

3 96) PPP0100R PSTTBCNT PXV0201C

3 97) PPP0100R PSTTBCNT PPP0201R

49) PPP0100R PSTTBCNT PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

3 98) PPP0100R PXV0300C PXV0200C

50) PPP0100R PXV0300C PXV0200C

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

R/	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3  
3

99) PPP0100R PXV0300C PPM0002A

100) PPP0100R PXV0300C PPM0002F

51) PPP0100R PXV0300C PPM0002F

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3  
3  
3

101) PPP0100R PXV0300C JBS0002B

102) PPP0100R PXV0300C PXV0201C

103) PPP0100R PXV0300C PPP0201R

52) PPP0100R PXV0300C PPP0201R

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

3

104) PPP0100R PPM0003F PXV0200C

53) PPP0100R PPM0003F PXV0200C

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3  
3

105) PPP0100R PPM0003F PPM0002A

106) PPP0100R PPM0003F PPM0002F

54) PPP0100R PPM0003F PPM0002F

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
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IMPACT

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16

- 3 107) PPP0100R PPM0003F JBS0002B
- 3 108) PPP0100R PPM0003F PXV0201C
- 3 109) PPP0100R PPM0003F PPP0201R

55) PPP0100R PPM0003F PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

- 3 110) PPP0100R PXV0301C PXV0200C
- 3 111) PPP0100R PXV0301C PPM0002A
- 3 112) PPP0100R PXV0301C PPM0002F
- 3 113) PPP0100R PXV0301C JBS0002B
- 3 114) PPP0100R PXV0301C PXV0201C
- 3 115) PPP0100R PXV0301C PPP0201R
- 3 116) PPP0100R PPP0301R PXV0200C

56) PPP0100R PPP0301R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

- 3 117) PPP0100R PPP0301R PPM0002A
- 3 118) PPP0100R PPP0301R PPM0002F

57) PPP0100R PPP0301R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

- 3 119) PPP0100R PPP0301R JBS0002B
- 3 120) PPP0100R PPP0301R PXV0201C
- 3 121) PPP0100R PPP0301R PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27
COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

3 122) PXV0100C PSTTBCNT PXV0200C

59) PXV0100C PSTTBCNT PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 123) PXV0100C PSTTBCNT PPM0002A

3 124) PXV0100C PSTTBCNT PPM0002F

60) PXV0100C PSTTBCNT PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 125) PXV0100C PSTTBCNT JBS0002B

3 126) PXV0100C PSTTBCNT PXV0201C

3 127) PXV0100C PSTTBCNT PPP0201R

61) PXV0100C PSTTBCNT PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

128) PXV0100C PXV0300C PXV0200C

62) PXV0100C PXV0300C PXV0200C

COMMON CONDITION -- FIRST CRITERION

RANK: MIN MAX AVG SUM

MANUFACTURER - V

9 9 9 27

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 5 5 15

129) PXV0100C PXV0300C PPM0002A

130) PXV0100C PXV0300C PPM0002F

63) PXV0100C PXV0300C PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 5 5 15

131) PXV0100C PXV0300C JBS0002B

132) PXV0100C PXV0300C PXV0201C

64) PXV0100C PXV0300C PXV0201C

COMMON CONDITION -- FIRST CRITERION  
 MANUFACTURER - V

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

133) PXV0100C PXV0300C PPP0201R

3

65) PXV0100C PXV0300C PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

134) PXV0100C PPM0003F PXV0200C

3

66) PXV0100C PPM0003F PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

135) PXV0100C PPM0003F PPM0002A

3

136) PXV0100C PPM0003F PPM0002F

3

67) PXV0100C PPM0003F PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

137) PXV0100C PPM0003F JBS0002B

3

138) PXV0100C PPM0003F PXV0201C

3

139) PXV0100C PPM0003F PPP0201R

3

68) PXV0100C PPM0003F PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK: MIN MAX AVG SUM  
5 6 5 16

140) PXV0100C PXV0301C PXV0200C

3

69) PXV0100C PXV0301C PXV0200C

COMMON CONDITION -- FIRST CRITERION  
MANUFACTURER - V

RANK: MIN MAX AVG SUM  
9 9 9 27

141) PXV0100C PXV0301C PPM0002A

3

142) PXV0100C PXV0301C PPM0002F

3

143) PXV0100C PXV0301C JBS0002B

3

144) PXV0100C PXV0301C PXV0201C

3

70) PXV0100C PXV0301C PXV0201C

COMMON CONDITION -- FIRST CRITERION  
MANUFACTURER - V

RANK: MIN MAX AVG SUM  
9 9 9 27

145) PXV0100C PXV0301C PPP0201R

3

146) PXV0100C PPP0301R PXV0200C

3

71) PXV0100C PPP0301R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK: MIN MAX AVG SUM  
5 6 5 16

CUT SETS WITH 3 COMPONENTS

3 147) PXV0100C PPP0301R PPM0002A  
 3 148) PXV0100C PPP0301R PPM0002F

72) PXV0100C PPP0301R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 149) PXV0100C PPP0301R JBS0002B  
 3 150) PXV0100C PPP0301R PXV0201C  
 3 151) PXV0100C PPP0301R PPP0201R

73) PXV0100C PPP0301R PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 152) PPM0001A PSTTBCNT PXV0200C  
 3 153) PPM0001A PSTTBCNT PPM0002A  
 3 154) PPM0001A PSTTBCNT PPM0002F  
 3 155) PPM0001A PSTTBCNT JBS0002B  
 3 156) PPM0001A PSTTBCNT PXV0201C  
 3 157) PPM0001A PSTTBCNT PPP0201R  
 3 158) PPM0001A PXV0300C PXV0200C  
 3 159) PPM0001A PXV0300C PPM0002A  
 3 160) PPM0001A PXV0300C PPM0002F  
 3 161) PPM0001A PXV0300C JBS0002B  
 3 162) PPM0001A PXV0300C PXV0201C  
 3 163) PPM0001A PXV0300C PPP0201R  
 3 164) PPM0001A PPM0003F PXV0200C

3

165) PPM0001A PPM0003F PPM0002A

74) PPM0001A PPM0003F PPM0002A

COMMON CONDITION -- FIRST CRITERION

RANK: MIN MAX AVG SUM

MANUFACTURER - U

9 9 9 27

3

166) PPM0001A PPM0003F PPM0002F

75) PPM0001A PPM0003F PPM0002F

COMMON CONDITION -- FIRST CRITERION

MANUFACTURER - U

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

- 3 167) PPM0001A PPM0003F JBS0002B
- 3 168) PPM0001A PPM0003F PXV0201C
- 3 169) PPM0001A PPM0003F PPP0201R
- 3 170) PPM0001A PXV0301C PXV0200C
- 3 171) PPM0001A PXV0301C PPM0002A
- 3 172) PPM0001A PXV0301C PPM0002F
- 3 173) PPM0001A PXV0301C JBS0002B
- 3 174) PPM0001A PXV0301C PXV0201C
- 3 175) PPM0001A PXV0301C PPP0201R
- 3 176) PPM0001A PPP0301R PXV0200C
- 3 177) PPM0001A PPP0301R PPM0002A
- 3 178) PPM0001A PPP0301R PPM0002F
- 3 179) PPM0001A PPP0301R JBS0002B
- 3 180) PPM0001A PPP0301R PXV0201C
- 3 181) PPM0001A PPP0301R PPP0201R
- 3 182) PPM0001F PSTTBCNT PXV0200C

76) PPM0001F PSTTBCNT PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

- 3 183) PPM0001F PSTTBCNT PPM0002A
- 3 184) PPM0001F PSTTBCNT PPM0002F

PPM0001F PSTTBCNT PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT 5 6 5 16

185) PPM0001F PSTTBCNT JBS0002B

186) PPM0001F PSTTBCNT PXV0201C

187) PPM0001F PSTTBCNT PPP0201R

78) PPM0001F PSTTBCNT PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT 5 6 5 17

188) PPM0001F PXV0300C PXV0200C

79) PPM0001F PXV0300C PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT 5 5 5 15

189) PPM0001F PXV0300C PPM0002A

190) PPM0001F PXV0300C PPM0002F

80) PPM0001F PXV0300C PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT 5 5 5 15

191) PPM0001F PXV0300C JBS0002B

192) PPM0001F PXV0300C PXV0201C

193) PPM0001F PXV0300C PPP0201R

PPM0001F PXV0300C PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3

194) PPM0001F PPM0003F PXV0200C

82) PPM0001F PPM0003F PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

IMPACT

3

195) PPM0001F PPM0003F PPM0002A

83) PPM0001F PPM0003F PPM0002A

COMMON CONDITION -- FIRST CRITERION

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

MANUFACTURER - U

3

196) PPM0001F PPM0003F PPM0002F

84) PPM0001F PPM0003F PPM0002F

COMMON CONDITION -- FIRST CRITERION

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

MANUFACTURER - U

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15
	5	5	5	15

IMPACT

TEMPERATURE

3

197) PPM0001F PPM0003F JBS0002B

3

198) PPM0001F PPM0003F PXV0201C

3

199) PPM0001F PPM0003F PPP0201R

85) PPM0001F PPM0003F PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

200) PPM0001F PXV0301C PXV0200C

201) PPM0001F PXV0301C PPM0002A

3

3

CUT SETS WITH 3 COMPONENTS

- 3 202) PPM0001F PXV0301C PPM0002F
- 3 203) PPM0001F PXV0301C JBS0002B
- 3 204) PPM0001F PXV0301C PXV0201C
- 3 205) PPM0001F PXV0301C PPP0201R
- 3 206) PPM0001F PPP0301R PXV0200C

86) PPM0001F PPP0301R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

- 3 207) PPM0001F PPP0301R PPM0002A
- 3 208) PPM0001F PPP0301R PPM0002F

87) PPM0001F PPP0301R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

- 3 209) PPM0001F PPP0301R JBS0002B
- 3 210) PPM0001F PPP0301R PXV0201C
- 3 211) PPM0001F PPP0301R PPP0201R

88) PPM0001F PPP0301R PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

- 3 212) JBS0001B PSTTBCNT PXV0200C
- 3 213) JBS0001B PSTTBCNT PPM0002A

3 211) JBS0001B PSTTBCNT PPM0002F  
 3 215) JBS0001B PSTTBCNT JBS0002B  
 3 216) JBS0001B PSTTBCNT PXV0201C  
 3 217) JBS0001B PSTTBCNT PPP0201R  
 3 218) JBS0001B PXV0300C PXV0200C  
 3 219) JBS0001B PXV0300C PPM0002A  
 3 220) JBS0001B PXV0300C PPM0002F  
 3 221) JBS0001B PXV0300C JBS0002B  
 3 222) JBS0001B PXV0300C PXV0201C  
 3 223) JBS0001B PXV0300C PPP0201R  
 3 224) JBS0001B PPM0003F PXV0200C  
 3 225) JBS0001B PPM0003F PPM0002A  
 3 226) JBS0001B PPM0003F PPM0002F  
 3 227) JBS0001B PPM0003F JBS0002B  
 3 228) JBS0001B PPM0003F PXV0201C  
 3 229) JBS0001B PPM0003F PPP0201R  
 3 230) JBS0001B PXV0301C PXV0200C  
 3 231) JBS0001B PXV0301C PPM0002A  
 3 232) JBS0001B PXV0301C PPM0002F  
 3 233) JBS0001B PXV0301C JBS0002B  
 3 234) JBS0001B PXV0301C PXV0201C  
 3 235) JBS0001B PXV0301C PPP0201R  
 3 236) JBS0001B PPP0301R PXV0200C  
 3 237) JBS0001B PPP0301R PPM0002A  
 3 238) JBS0001B PPP0301R PPM0002F  
 3 239) JBS0001B PPP0301R JBS0002B  
 3 240) JBS0001B PPP0301R PXV0201C  
 3 241) JBS0001B PPP0301R PPP0201R  
 3 242) PXV0101C PSTTBCNT PXV0200C

89) PXV0101C PSTTBCNT PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3 243) PXV0101C PSTTBCNT PPM0002A  
3 244) PXV0101C PSTTBCNT PPM0002F

90) PXV0101C PSTTBCNT PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 245) PXV0101C PSTTBCNT JBS0002B  
3 246) PXV0101C PSTTBCNT PXV0201C  
3 247) PXV0101C PSTTBCNT PPP0201R

91) PXV0101C PSTTBCNT PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 248) PXV0101C PXV0300C PXV0200C

92) PXV0101C PXV0300C PXV0200C

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - V		9	9	9	27

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	5	5	15

3 249) PXV0101C PXV0300C PPM0002A  
3 250) PXV0101C PXV0300C PPM0002F

93) PXV0101C PXV0300C PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

IMPACT

3 251) PXV0101C PXV0300C JBS0002B

3 252) PXV0101C PXV0300C PXV0201C

94) PXV0101C PXV0300C PXV0201C

COMMON CONDITION -- FIRST CRITERION

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

MANUFACTURER - V

3 253) PXV0101C PXV0300C PPP0201R

95) PXV0101C PXV0300C PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3

254) PXV0101C PPM0003F PXV0200C

96) PXV0101C PPM0003F PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

3

255) PXV0101C PPM0003F PPM0002A

3

256) PXV0101C PPM0003F PPM0002F

97) PXV0101C PPM0003F PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

CUT SETS WITH 3 COMPONENTS

- 3 257) PXV0101C PPM0003F JBS0002B
- 3 258) PXV0101C PPM0003F PXV0201C
- 3 259) PXV0101C PPM0003F PPP0201R
  
- 98) PXV0101C PPM0003F PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

- 3 260) PXV0101C PXV0301C PXV0200C
  
- 99) PXV0101C PXV0301C PXV0200C

COMMON CONDITION -- FIRST CRITERION  
 MANUFACTURER - V

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

- 3 261) PXV0101C PXV0301C PPM0002A
- 3 262) PXV0101C PXV0301C PPM0002F
- 3 263) PXV0101C PXV0301C JBS0002B
- 3 264) PXV0101C PXV0301C PXV0201C
  
- 100) PXV0101C PXV0301C PXV0201C

COMMON CONDITION -- FIRST CRITERION  
 MANUFACTURER - V

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

- 3 265) PXV0101C PXV0301C PPP0201R
- 3 266) PXV0101C PPP0301R PXV0200C
  
- 101) PXV0101C PPP0301R PXV0200C

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RA	MIN	MAX	AVG	SUM
IMPACT	5	6	5	16

267) PXV0101C PPP0301R PPM0002A

3

268) PXV0101C PPP0301R PPM0002F

3

102) PXV0101C PPP0301R PPM0002F

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
IMPACT	5	6	5	16

269) PXV0101C PPP0301R JBS0002B

3

270) PXV0101C PPP0301R PXV0201C

3

271) PXV0101C PPP0301R PPP0201R

3

103) PXV0101C PPP0301R PPP0201R

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
IMPACT	5	6	5	17

272) PPP0101R PSTTBCNT PXV0200C

3

104) PPP0101R PSTTBCNT PXV0200C

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
IMPACT	5	6	5	17

273) PPP0101R PSTTBCNT PPM0002A

3

274) PPP0101R PSTTBCNT PPM0002F

3

105) PPP0101R PSTTBCNT PPM0002F

## COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
-------	-----	-----	-----	-----

IMPACT

5

6

5

17

275) PPP0101R PSTTBCNT JBS0002B

3

276) PPP0101R PSTTBCNT PXV0201C

3

106) PPP0101R PSTTBCNT PXV0201C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

3 277) PPP0101R PSTTBCNT PPP0201R

107) PPP0101R PSTTBCNT PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

3 278) PPP0101R PXV0300C PXV0200C

108) PPP0101R PXV0300C PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 279) PPP0101R PXV0300C PPM0002A

3 280) PPP0101R PXV0300C PPM0002F

109) PPP0101R PXV0300C PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	16

3 2 PPP0101R PXV0300C JBS0002B  
3 282) PPP0101R PXV0300C PXV0201C  
3 283) PPP0101R PXV0300C PPP0201R

110) PPP0101R PXV0300C PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3 284) PPP0101R PPM0003F PXV0200C

111) PPP0101R PPM0003F PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3 285) PPP0101R PPM0003F PPM0002A  
3 286) PPP0101R PPM0003F PPM0002F

112) PPP0101R PPM0003F PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3 287) PPP0101R PPM0003F JBS0002B  
3 288) PPP0101R PPM0003F PXV0201C  
3 289) PPP0101R PPM0003F PPP0201R

113) PPP0101R PPM0003F PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3 2 PPP0101R PXV0301C PXV0200C  
 3 291) PPP0101R PXV0301C PPM0002A  
 3 292) PPP0101R PXV0301C PPM0002F  
 3 293) PPP0101R PXV0301C JBS0002B  
 3 294) PPP0101R PXV0301C PXV0201C

114) PPP0101R PXV0301C PXV0201C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

3 295) PPP0101R PXV0301C PPP0201R

115) PPP0101R PXV0301C PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

3 296) PPP0101R PPP0301R PXV0200C

116) PPP0101R PPP0301R PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

297) PPP0101R PPP0301R PPM0002A

3  
3

298) PPP0101R PPP0301R PPM0002F

117) PPP0101R PPP0301R PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

299) PPP0101R PPP0301R JBS0002B

3  
3

300) PPP0101R PPP0301R PXV0201C

118) PPP0101R PPP0301R PXV0201C

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		5	6	5	17

301) PPP0101R PPP0301R PPP0201R

3

119) PPP0101R PPP0301R PPP0201R

COMMON CONDITION -- FIRST CRITERION	RANK:	MIN	MAX	AVG	SUM
MANUFACTURER - P		9	9	9	27

COMMON SUSCEPTIBILITY -- SECOND CRITERION	RANK:	MIN	MAX	AVG	SUM
IMPACT		6	6	6	18
VIBRATION		5	5	5	15

3

302) PPP0100R EMV0001D PXV0200C

120) PPP0100R EMV0001D PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3

303) PPP0100R EMV0001D PPM0002A

3

304) PPP0100R EMV0001D PPM0002F

121) PPP0100R EMV0001D PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

3

305) PPP0100R EMV0001D JBS0002B

3

306) PPP0100R EMV0001D PXV0201C

3

307) PPP0100R EMV0001D PPP0201R

122) PPP0100R EMV0001D PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

3

308) PXV0100C EMV0001D PXV0200C

123) PXV0100C EMV0001D PXV0200C

COMMON CONDITION -- FIRST CRITERION

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

MANUFACTURER - V

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

IMPACT

3  
 3

309) PXV0100C EMV0001D PPM0002A

310) PXV0100C EMV0001D PPM0002F

124) PXV0100C EMV0001D PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
 IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

3

311) PXV0100C EMV0001D JBS0002B

RANK:	MIN	MAX	AVG	SUM
	5	5	5	17

RANK:	MIN	MAX	AVG	SUM
	5	5	5	17

RANK:	MIN	MAX	AVG	SUM
	5	5	5	27

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15
	5	5	5	15

CUT SETS WITH 3 COMPONENTS

312) PXV0100C EMV0001D PXV0201C

3

125) PXV0100C EMV0001D PXV0201C

COMMON CONDITION -- FIRST CRITERION  
MANUFACTURER - V

RANK:	MIN	MAX	AVG	SUM
	9	9	9	27

313) PXV0100C EMV0001D PPP0201R

3

126) PXV0100C EMV0001D PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

314) PPM0001A EMV0001D PXV0200C

3

315) PPM0001A EMV0001D PPM0002A

3

316) PPM0001A EMV0001D PPM0002F

3

317) PPM0001A EMV0001D JBS0002B

3

318) PPM0001A EMV0001D PXV0201C

3

319) PPM0001A EMV0001D PPP0201R

3

320) PPM0001F EMV0001D PXV0200C

3

127) PPM0001F EMV0001D PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION  
IMPACT

RANK:	MIN	MAX	AVG	SUM
	5	5	5	15

321) PPM0001F EMV0001D PPM0002A

3

322) PPM0001F EMV0001D PPM0002F

3

128) PPM0001F EMV0001D PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 5 5 15

3  
3  
3

323) PPM0001F EMV0001D JBS0002B

324) PPM0001F EMV0001D PXV0201C

325) PPM0001F EMV0001D PPP0201R

129) PPM0001F EMV0001D PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 6 5 16

3  
3  
3  
3  
3  
3  
3

326) JBS0001B EMV0001D PXV0200C

327) JBS0001B EMV0001D PPM0002A

328) JBS0001B EMV0001D PPM0002F

329) JBS0001B EMV0001D JBS0002B

330) JBS0001B EMV0001D PXV0201C

331) JBS0001B EMV0001D PPP0201R

332) PXV0101C EMV0001D PXV0200C

130) PXV0101C EMV0001D PXV0200C

COMMON CONDITION -- FIRST CRITERION

RANK: MIN MAX AVG SUM

MANUFACTURER - V

9 9 9 27

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5 5 5 15

3  
3

333) PXV0101C EMV0001D PPM0002A

334) PXV0101C EMV0001D PPM0002F

131) PXV0101C EMV0001D PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN MAX AVG SUM

IMPACT

5

5

5

15

235) PXV0101C EMV0001D JBS0002B

3

336) PXV0101C EMV0001D PXV0201C

3

132) PXV0101C EMV0001D PXV0201C

COMMON CONDITION -- FIRST CRITERION

RANK: MIN

MAX

AVG

SUM

MANUFACTURER - V

9

9

9

27

337) PXV0101C EMV0001D PPP0201R

3

133) PXV0101C EMV0001D PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

16

338) PPP0101R EMV0001D PXV0200C

3

134) PPP0101R EMV0001D PXV0200C

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK: MIN

MAX

AVG

SUM

IMPACT

5

6

5

16

339) PPP0101R EMV0001D PPM0002A

3

340) PPP0101R EMV0001D PPM0002F

3

135) PPP0101R EMV0001D PPM0002F

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	16

IMPACT

341) PPP0101R EMV0001D JBS0002B

3

342) PPP0101R EMV0001D PXV0201C

3

343) PPP0101R EMV0001D PPP0201R

3

136) PPP0101R EMV0001D PPP0201R

COMMON SUSCEPTIBILITY -- SECOND CRITERION

RANK:	MIN	MAX	AVG	SUM
	5	6	5	17

IMPACT

TOTAL NUMBER OF CUT SETS FOUND WAS 345

ALL CUT SETS HAVE BEEN DETERMINED.

THE NUMBER OF CUT SETS TESTED IS 344

QUALITATIVE FAILURE CHARACTERISTICS

IMPACT		
DOMAIN	1MPA	
	I16	2 2
DOMAIN	2MPA	
	I15	3 3
	I15	4 5
	I15	5 7
	I16	6 8
	I16	7 9
	I15	8 10
	I15	9 11
	I16	10 13
	I15	11 14
	I15	12 15
	I15	13 16
	I15	14 18
	I15	15 24
	I15	16 25
	I15	17 26
	I15	18 28
	I15	19 34
	I15	20 35
	I15	21 36
	I15	22 38
	I16	23 39
	I15	24 40
	I15	25 41
	I16	26 43
	I15	27 44
	I15	28 45
	I15	29 47
	I15	30 49
	I15	31 50
	I15	32 51
	I15	33 53
	I16	34 56
	I15	35 57
	I15	36 59
	I15	37 62
	I15	38 69
	I15	39 71
	I15	40 74
	I15	41 81
	I15	42 83
	I15	43 86
	I15	44 87
	I15	45 89
	I16	46 92
	I15	47 93
	I15	48 95
	I16	49 98
	I15	50 99
	I15	51 101
	I15	52 104
	I15	53 105
	I15	54 107
	I15	55 110
	I15	56 117
	I15	57 119

I16 58 122  
I15 59 123  
I15 60 125  
I15 61 128  
I15 62 129  
I15 63 131  
I15 65 134  
I15 66 135  
I15 67 137  
I15 68 140  
I15 71 147  
I15 72 149  
I15 73 152  
I15 76 183  
I15 77 185  
I15 78 188  
I15 79 189  
I15 80 191  
I15 81 194  
I15 82 195  
I15 84 197  
I15 85 200  
I15 86 207  
I15 87 209  
I15 88 212  
I15 89 243  
I15 90 245  
I15 91 248  
I15 92 249  
I15 93 251  
I15 95 254  
I15 96 255  
I15 97 257  
I15 98 260  
I15101 267  
I15102 269  
I15103 272  
I15104 273  
I15105 275  
I16107 278  
I15108 279  
I15109 281  
I15110 284  
I15111 285  
I15112 287  
I15113 290  
I15116 297  
I15117 299  
I16119 302  
I15120 303  
I15121 305  
I15122 308  
I15123 309  
I15124 311  
I15126 314  
I15127 321  
I15128 323  
I15129 326  
I15130 333  
I15131 335  
I15133 338  
I15134 339  
I15135 341  
I15136 344

DOMAIN 3MPA

I15106 277

I15114 295  
I15115 296  
I15118 301

VIBRATION

DOMAIN 1MPB  
U15 2 2  
U15 6 8  
U15 7 9  
U15 10 13  
U15 23 39  
U15 26 43  
U15 34 56  
U15 46 92  
U15 49 98  
U15 58 122  
U15107 278  
U15119 302

PRESSURE

STRESS

TEMPERATURE

DOMAIN 2MPA  
T15 84 197

CURRENT

GRIT

MOISTURE

CORROSION (ACID)

DOMAIN 3MPA  
A36 1 1

CORROSION (OXIDATION)

DOMAIN 3MPA  
O37 1 1

CHEMICAL REACTION

DOMAIN 3MPA  
R38 1 1

F AULIC LOOP - 1

HYDRAULIC LOOP - 2

HYDRAULIC LOOP - 3

HYDRAULIC LOOP - 4  
N44 1 1

POWER SUPPLY - 1

POWER SUPPLY - 2

POWER SUPPLY - 3

MAINTENANCE PROCEDURE 1

MAINTENANCE PROCEDURE 2

MAINTENANCE PROCEDURE 3

MAINTENANCE PROCEDURE 4

TEST PROCEDURE - 1

TEST PROCEDURE - 2

TEST PROCEDURE - 3

MANUFACTURER - T

MANUFACTURER - V  
V 5 62 129  
V 5 64 133  
V 5 69 141

V 5 70 145  
V 5 92 249  
V 5 94 253  
V 5 99 261  
V 5100 265  
V 5123 309  
V 5125 313  
V 5130 333  
V 5132 337

MANUFACTURER - P

P 5 2 2  
P 5 6 8  
P 5 7 9  
P 5 10 13  
P 5 23 39  
P 5 26 43  
P 5 34 56  
P 5 46 92  
P 5 49 98  
P 5 58 122  
P 5107 278  
P 5119 302

MANUFACTURER - U

U 5 74 166  
U 5 75 167  
U 5 83 196  
U 5 84 197

MANUFACTURER - H

H 5 1 1

MANUFACTURER - E

THIS CONCLUDES THE OUTPUT FROM BACFIRE.

THE W ARRAY IS DIMENSIONED FOR 20000 REAL\*8 WORDS.

479 WORDS WERE USED AND THERE WERE 19521 EXCESS.

MOCUS USED 345 ROWS AND 3 COLUMNS IN THE ICS MATRIX.

EXTERNAL SCRATCH STORAGE WAS NOT REQUIRED.

- - - - CONCLUSION OF MOCUS OUTPUT - - - -

Appendix F

MOCUS-BACFIRE  
Programme Listing